MONHEGAN HARBOR

MAINE

SURVEY

(REVIEW OF REPORTS)

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

JULY 16, 1962

REVIEW OF REPORTS

MONHEGAN HARBOR

MONHEGAN ISLAND, MAINE

SYLLABUS

The Division Engineer has studied the general navigation problem at Monhegan Harbor and finds that construction of a breakwater would be required to improve conditions for the existing lobster fishing fleet and provide shelter for mooring additional commercial and recreational craft. The most economical and suitable breakwater would cost $832,000.

The annual benefits from such a breakwater have been evaluated and amount to $36,150. The annual charges would be $40,950 which yields a benefit-cost ratio of 0.9. Inasmuch as the benefit-cost ratio is less than 1.0 the project is not economically justified. Because this breakwater is not economically justified, and no smaller or larger breakwater system would be any better, no improvement at Monhegan is recommended at this time.

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U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 Trapelo Road
Waltham 54, Mass.

NEDGW 16 July 1962

SUBJECT: Survey (Review of Reports) of Monhegan Harbor, Maine

TO: Chief of Engineers
ATTN: ENGCW-P
Department of the Army
Washington 25, D. C.

AUTHORITY

1. This report is submitted in compliance with the following resolutions, adopted by the Committee on Public Works of the United States Senate, 28 April 1958, and the House Committee on Public Works, 16 July 1958, respectively:

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13,1902, be, and is hereby, requested to review the reports of the Chief of Engineers on Monhegan Harbor, Maine, transmitted to Congress on 18 July 1941, and other reports, with a view to determining whether any modification of the recommendations contained therein is advisable at this time."

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Monhegan Harbor, Maine, submitted 28 April 1941 and prior reports, with a view to determining if the recommendation submitted therein should be modified in any way at this time."

2. The study was assigned to the New England Division on 30 July 1958.

PURPOSE AND EXTENT OF STUDY

3. The study was made to determine the need and justification of Federal navigation improvement at Monhegan Island, Maine. In preparation of this report a detailed hydrographic survey was made. The survey included soundings and probings in the areas in the vicinity of the proposed breakwater. A study was made of available data on the present and prospective use of the harbor after the improvement is completed. A public hearing was held at Monhegan Island, 2 December 1958. Information obtained at the hearing is described later under "Improvement Desired". Subsequently local interests were consulted to obtain current data to supplement information previously submitted and obtain comments on the study indications. Available maps, charts, and aerial photographs were studied.

DESCRIPTION OF NAVIGATION CONDITIONS

4. Monhegan Island lies about 8 miles off the coast of Maine, 17 miles southeast of Boothbay Harbor, 11 miles southwest of Port Clyde, and 46 miles east of Portland, Maine. The island, which has a maximum elevation of 160 feet, is about 8,000 feet long and 3,000 feet wide. Monhegan Light, a fixed white light visible for 20 miles, is located near the center of the island. The harbor, about 2,000 feet long, lies off the southwest corner of the island. It is bounded on the west by Manana Island and partially on the north by Smutty Nose Island. The width of the harbor increases from about 650 feet just south of the northerly entrance between Smutty Nose Island and Monhegan Islands to about 1,000 feet at the south entrance, which is exposed to heavy seas resulting from strong winds from the south and southwest. Depths in the harbor range from about 15 feet at the wharf near the north end of the harbor to 90 feet at the south entrance. In general, the shores are rocky. The bottom is considerably fouled with moorings and cables and offers a poor holding ground of coarse, white sand. The mean range of tide is 9.3 feet and the spring range is 10.6 feet. The location of Monhegan Island and its harbor is shown on U. S. Coast and Geodetic Survey Charts Nos. 1203 and 1204, and on the maps which accompany this report.

TRIBUTARY AREA

5. The area tributary to Monhegan Harbor is the Plantation of Monhegan, consisting of Manana and Monhegan Islands, the population of which is about 65 persons. During the summer months the population is augmented to a total of about 500 by summer residents and visitors. Aside from catering to the wants of their summer clientele, permanent residents of the island are engaged almost exclusively in fishing and lobstering. Property on the island has a total valuation of $178,452 (1960).

BRIDGES AFFECTING NAVIGATION

6. There are no existing or proposed bridges in the area.

PRIOR REPORTS

7. Monhegan Harbor has been the subject of seven reports since about 1888. Five of these reports (preliminary examination reports and surveys on breakwater protection) were not published. One was published in the Annual Report of the Chief of Engineers for 1889, and one in House Document No. 536, 64th Congress, 1st session. Tabulated hereinafter are the reports on record.

Type	Date and Where Published	Remarks
Preliminary Exam	27 December 1888 Annual Report of Chief of Engineers for 1889, Page 547	Unfavorable to further study of desired breakwater.
Preliminary Exam	12 October 1915 House Doc. 536, 64th Congress, 1st Session	Unfavorable to further study of desired breakwater.
Preliminary Exam	4 October 1930 Not Published	Favorable to survey.
Survey	15 March 1932 Not Published	Unfavorable to construction of desired or considered breakwater, then estimated to cost $550,000, because of insufficient benefits.
Preliminary Exam	20 December 1935 Not Published	Unfavorable to further study.
Preliminary Exam	26 October 1939 Not Published	Unfavorable to further study.
Survey	30 October 1940 Not Published	Unfavorable to two considered breakwater plans, one then estimated to cost $150,000 and the other then estimated at $88,000 because the total storm damage plus gains to accrue from increased fishing time would be less than the carrying charges. Other plans considered would not meet navigation needs.

EXISTING CORPS OF ENGINEERS PROJECT

8. There is no existing Federal project for the improvement of Monhegan Harbor. No project for improvement of this area has ever been adopted by the Federal Government, nor has any navigation improvement been made by local interests, other than wharf facilities.

TERMINAL AND TRANSFER FACILITIES

9. The principal wharf in Monhegan Harbor is a stone structure at the northerly end of the harbor, built and maintained by the Plantation of Monhegan at a cost of about $12,000 and open to all without charge. A depth of about 15 feet is available at the end of this wharf and the structure appears to provide adequately for all present and prospective needs of the community. A small Coast Guard wharf and launchway are located across the harbor on Manana Island. On the Monhegan Island side of the harbor, a small beach (known as Fish Beach) is available for use by fishing craft and other small boats. The nearest rail connection is located at Thomaston, Maine, 23 miles northeast of the island. The nearest highway is at Port Clyde.

IMPROVEMENT DESIRED

10. In order to afford local interests an opporutnity to express their views on the extent and character of the improvement desired, a public hearing was held at Monhegan, Maine, on 2 December 1958. Present at the hearing were the officials of the Plantation of Monhegan, fishing and business interests, State and Government representatives and officials, and other local residents. Several written statements were received from interested individuals who were unable to attend the hearing in person.

11. Representatives of the Plantation of Monhegan requested the construction of a breakwater on the eastern shore of the harbor. Proponents of this improvement urged its necessity as a means of protecting the fishing fleet, and as a safeguard to the lives of those engaged in operating the fleet. It was also claimed that the desired breakwater would largely eliminate the hazards now involved in landing freight, passengers, and mail at the public wharf, and would improve anchorage conditions both for the local boats and for resident and transient fishing and other commercial and pleasure craft using the harbor. The harbor created by the breakwater would afford a safe harbor and point of layover for resident and transient fishing fleets and pleasure craft in the area in time of bad seas. Freighters and tankers requesting pilots would not be delayed because pilots could not reach the ship requesting assistance. The breakwater would also result in a

reduction of $1,150 in lobster car losses per year, improve lobster fishing time 25 percent and provide $15,200 in benefits to the lobster fishing trade. Elimination of annual repair costs to town wharf would be an appreciable savings.

COMMERCE AND VESSEL TRAFFIC

12. Commerce to and from Monhegan Island consists of fuel, food, and other supplies required by the small community and its summer residents, and lobsters caught by the local fleet and shipped to the mainland. There are 15 lobster boats based in the harbor which are engaged in lobster fishing from January to June. Some of these boats groundfish during the closed lobster season. Also, during the summer there are about 75 rowboats, 20 outboards, and 2 sailboats based in the harbor.

13. There are numerous transient boats which visit the harbor, as the island is situated on the navigation route of recreational boats sailing the Maine Coast. These boats range in size from small outboards to large sailboats and commercial fishing trawlers. None of these boats remain overnight because of the rough and sometimes hazardous conditions in the harbor.

14. Although improvement of the harbor is not expected to cause any expansion in the existing lobster fleet, the recreational fleets, both home-based and transient, are expected to increase substantially. In addition, the transient commercial fishing vessels, which do not use the harbor at present, would be attracted if it were a safe refuge from storms. The desired improvement would provide such a safe anchorage for all craft using the area. A survey of yachting enthusiasts and boat clubs indicates that Monhegan Island would be a popular stopover, if the improvement were made.

DIFFICULTIES ATTENDING NAVIGATION

15. Because of its exposure to the open sea at its southerly entrance, Monhegan Harbor is subject to the effect of storms from the south and southwest that cause heavy seas to surge into the harbor and endanger anchored boats and lobster cars. These conditions result not only in frequent property damage, but also endanger the lives of those engaged in the fishing industry. During extreme conditions, a strong undertow is developed at the public wharf, making landings hazardous.

16. Statements in the "United States Coast Pilot" discourage small craft from landing at Monhegan. Several pilots have stated that at times the seas were so rough that they could not get out of the harbor to ships that requested and required pilot service. Other statements are that 15 percent of the requests for pilot service cannot be answered for up to 12 hours after the requests were made because the pilots could not get their craft out of the harbor. There are times when it is necessary for boats to circumnavigate the island around the north end to avoid the high seas in the south entrance. At night, when seas are rough, it is impossible to enter the harbor and secure a mooring.

WATER POWER AND OTHER SPECIAL SUBJECTS

17. There are no problems involved in this investigation pertaining to water power, flood control, pollution, or related subjects.

PLAN OF IMPROVEMENT

18. Local interests requested a breakwater to protect the harbor from wave action. The various factors evaluated in determining the best location of a breakwater to protect Monhegan Harbor are costs of the structure; the protected area provided by the breakwater versus the needs of the Plantation; consideration of design waves at various locations; comparison of volume requirements for various breakwater locations; consideration of wave reductions due to various breakwater locations as indicated by diffraction diagrams; consideration of the problems of navigating the entrance, and the benefits to be derived from the locations studied. Selection of any location for a breakwater involves a compromise between the factors of cost and effectiveness. Construction costs would be lowest near the head of the harbor. The effectiveness is improved by reducing the entrance width. The usefulness of the harbor requires an adequate sheltered area, a substantial reduction of wave heights at the town dock, and an entrance opening adequate for navigation.

19. Vessel traffic now uses the north entrance between Smutty Nose Island and Monhegan Island as well as the south entrance. Closing the south entrance would provide the most shelter but would restrict navigation when storm waves make the north entrance hazardous. It is not expected that waves would be hazardous at both the north and south ends of the harbor at the same time. Therefore, the south entrance may be much less wider than would be required if it had to be used during high wave periods.

20. The narrowest safe entrance in moderately bad wave conditions is considered to be about 75 feet. In view of the probability of wave reflection from the steep shorelines and the breakwater, a wider entrance would be preferable. However, a substantially wider entrance would not provide adequate protection to boats in the harbor. A channel 100 feet wide and 12 feet deep (and at least 150 feet wide at mean low water) would be adequate for navigation without substantially reducing the protection provided by the breakwater.

21. It has been concluded that the location of the most effective breakwater for Monhegan Harbor is about 750 feet from the town dock, with the breakwater extending from the Monhegan Island shore approximately 450 feet to a point which would leave a navigation opening 100 feet wide at 12 feet below mean low water. No further improvement beyond the breakwater is considered necessary. The present public wharf and shore facilities appear adequate for all users.

22. The proposed breakwater would shelter about 8 acres partially and 4 acres substantially, which would be sufficient for 40 smaller boats and 10 larger. The available space would provide adequate mooring area for recreational boats in the summer, and for a fishing fleet in addition to the home fleet during the winter. The space provided by the structure evaluated would meet the requirements of Monhegan Island.

23. The breakwater would be constructed of dense native quarry stone to an elevation of +26.0 with top width of 12'-0 and side slopes of 2 on 1 for the exposed side and 1-1/2 on 1 for the protected side. The structure would be placed on a mat approximately 2'-0 thick of quarry spoils and splinters. The core would be quarry run stone weighing between 650 and 1,300 pounds. The 6'-0 thick armor above MLW on the protected side and down to El. - 11.5 on the exposed side would consist of 2 layers of 6-1/2 ton stone. The lower portions of the armor below elevations noted above would be 6'-0 thick of 1/2 ton stone.

SHORELINE CHANGES

24. Inasmuch as the shore lines of Monhegan and Manana Islands are principally rock features, it is not expected that these shore lines will be changed by the action of the water or the breakwater. Since the sandy beach is located in the area to be protected, no change is expected to its shore line.

REQUIRED AIDS TO NAVIGATION

25. The U. S. Coast Guard has been consulted and has advised that the proposed breakwater would require a light at its outer end. The light will consist of a lens and battery box mounted atop a 16-inch square concrete pile 10 feet above the breakwater top. The estimated first cost is $4,000 and the annual maintenance cost is estimated at $100 per year.

ESTIMATES OF FIRST COST

26. The estimate of first cost prepared for the breakwater considered was based on the use of stone obtained locally from a quarry operation on Manana Island. It has been concluded that all construction operations should be carried forward from the shore of Manana Island as transportation of rock from the mainland would triple the cost because of delays due to rough seas. Quantities of stone were estimated in terms of place measure and unit prices used are based on 1962 quotations for the proposed operations plus an allowance for mobilization, overhead and contingencies. Detailed costs are included in Appendix A.

Estimated First Cost

Breakwater Construction (including contingencies)	$753,000
Engineering and Design	30,000
Supervision and Administration	45,000
Coast Guard - Aids to Navigation	4,000
Total Estimated First Cost (June 1962) *	$832,000

* Excludes preauthorization studies of $10,000

ESTIMATES OF ANNUAL CHARGES

27. The estimated annual charges have been computed on an assumed project life of 50 years at interest rates of 2.625 percent for Federal investment and 3.5 percent for local investment. The first costs are apportioned on the basis of general to local benefits. Maintenance costs are based on experience with other breakwaters of similar construction.

Estimates of Annual Charges

Apportionment of First Cost

a. Federal	
Corps of Engineers 86% ($828,000)	$712,000
Coast Guard - Aids to navigation	4,000
	$716,000
b. Non-Federal	
Cash contribution 14% ($828,000)	$116,000
	$832,000

Estimates of Annual Charges

a. Federal	
Interest at 2 5/8% plus amortization for 50 yrs.(0.03614)($716,000)	$25,900
Maintenance	
Corps of Engineers - Breakwater	10,000
Coast Guard - Aids to Navigation	100
	$36,000
b. Non-Federal	
Interest at 3 1/2% plus amortization for 50 yrs.(0.04263)($116,000)	$4,950
Total Annual Charges	$40,950

ESTIMATES OF BENEFITS

28. Construction of the selected breakwater at Monhegan Island would result in considerable annual benefits. Studies indicate that if the harbor were safer for lobster boats and other commercial fishing craft, the use of the harbor as a home port and as a port of refuge would be expanded. There would also be benefits to recreational craft attracted to this picturesque island during the vacation boating season.

29. Benefits to the present lobster fishing fleet would be obtained by the elimination of lost time due to storms when the boats cannot leave the harbor to tend to their traps, and to the reduction of damage to vessels and operating equipment.

30. Monhegan Island is a pilot station for ships using the State of Maine ports. At present, pilot service is delayed because of the difficulty of leaving the harbor during storms. Part of these delays to commercial shipping could be eliminated by construction of the breakwater.

31. The breakwater considered would provide refuge for the transient fishing fleet, which now sometimes moors in the lee of the island for protection during storms. In addition, the harbor would be calm enough for recreational boats to moor overnight. Due to the attractiveness of the island, a considerable increase in recreational boating use of the harbor would naturally follow the construction of the breakwater.

32. The benefits described above are evaluated in detail in Appendix D of this report and summarized below.

	Allocated		
Type of Benefit	General	Local	Total
Increased Lobster Catch	$15,200	-	$15,200
Reduced Damage to:			
Lobster Gear	1,400	-	1,400
Mooring Lines	750	-	750
Lobster Cars	1,150	-	1,150
Lobster Boats	1,100	-	1,100
Savings to Transient Fishing Fleet	1,600	-	1,600
Reduced Commercial Shipping Delays	6,150	-	6,150
Increased Recreational Boating			
Existing Home Fleet	150	150	300
Prospective Home Fleet	550	550	1,100
Present Transient Craft	650	650	1,300
Prospective Transient Craft	2,500	2,500	5,000
Reduced Shore and Wharf Damages	-	1,100	1,100
TOTAL DOLLARS	$31,200	$4,950	$36,150
PERCENT	86%	14%	100%

COMPARISON OF BENEFITS AND COSTS

33. The evaluated annual benefits of $36,150 and the annual charges of $40,950 for the improvement of Monhegan Harbor reveals a ratio of benefits to charges of 0.9 to 1 for the project. This ratio indicates the improvement is not economically justified.

LOCAL COOPERATION

34. If a Federal project were constructed certain items of local cooperation would be required. The benefits to be derived from the proposed breakwater are 86 percent general and 14 percent local in-nature. It is, therefore, considered that local interests should be required to contribute 14 percent of the breakwater construction cost as their portion of the cost of construction. This cash contribution is now estimated to be $116,000.

35. Local interests should be required to furnish a quarry site on Manana Island for the stone necessary to construct the breakwater without any additional cost to the Federal Government. If the stone had to be obtained from the mainland and shipped to the harbor, the cost of the structure would be prohibitive.

36. Local interests should be required to provide without cost to the United States all lands, easements and rights-of-way required for construction and subsequent maintenance of the project and for aids to navigation upon the request of the Chief of Engineers.

37. Local interests should be required to provide and maintain at local expense an adequate public terminal, transfer facilities and mooring facilities open to all on equal terms, and establish a competent and properly constituted public body empowered to regulate the use, growth and free development of the harbor facilities with the understanding that said facilities will be open to all on equal terms. The existing wharf and terminal facilities are deemed adequate for all present and prospective traffic, but additional moorings to provide a total of 45 moorings should be installed, and all should be properly maintained.

APPORTIONMENT OF COSTS AMONG INTERESTS

38. The apportionment of first costs of construction between the Federal Government and local interests is made on the basis of the proportion of general and local benefits. The total cost of the proposed breakwater is $832,000 with a subsequent maintenance cost of $10,100 annually. The Federal Government has been apportioned 86 percent, or

$712,000, for initial construction, plus $10,000 for annual maintenance. The United States Coast Guard has been apportioned $4,000 for aids to navigation in the initial construction, plus $100 annual maintenance.

39. Local interests have been apportioned 14 percent of the breakwater cost of $828,000, which would be a cash contribution amounting to $116,000 for their share of the first costs of construction, and in addition would be required to furnish a quarry site on Manana Island for obtaining all stone required to construct the breakwater.

COORDINATION WITH OTHER AGENCIES

40. All Federal, State and Local agencies interested in the development and improvement of Monhegan Harbor were notified of the public hearing held at Monhegan, Maine on 2 December 1958. The Maine Port Authority was consulted during the studies. All agencies expressed an interest in and were in favor of the proposed plan of improvement.

41. The United States Fish and Wildlife Service has been advised of the proposed construction and has no objection to the improvements under consideration. The Service provided information concerning the anticipated lobster catch after the improvement is made, and the estimates furnished were considered in the benefits computed. Their report is given in Appendix C. Local interests were consulted on the study indications and have replied that the requirements of cooperation would be met for a Federal project, and expressed their disappointment that the breakwater does not appear justified. The Maine Port Authority considered the possibility of submitting additional supporting data but reported that it appears all available and necessary information is on file. The Monhegan Breakwater Committee feels that the town should have more consideration on the construction of the breakwater.

DISCUSSION

42. Monhegan Harbor is a strait extending generally north and south between the islands of Manana and Monhegan, which lie about 8 miles off the coast of Maine. It is exposed to winds and waves and seas running from SSE, S, or SW, which limit the number of moorings that can be used and make landings at the wharf dangerous or impossible during storms. The harbor is used by 15 lobster fishermen, and during the summer season recreational craft cruising the Maine coast stop over briefly during daylight hours. When winds are blowing into the harbor, it is uncomfortable for pleasure craft.

43. Monhegan is a picturesque island with a permanent population of 65, of whom 15 are lobstermen. The economy is based on fishing and providing for visitors that increase the population to about 500 in the summer. The assessed value of the island property is under $200,000, and the value of the fishing fleet and gear is about $200,000.

44. A breakwater is needed to increase the usefulness of the harbor by creating a sheltered area adequate for the existing and reasonably prospective fleet. The most suitable breakwater to provide the desired protection for the harbor was found to be a stone structure extending from Monhegan shore 450 feet to a point which would leave a navigation opening 100 feet wide at 12' below m.l.w. This breakwater is estimated to cost $828,000 (June 1962), of which local interests would be required to contribute 14 percent or $116,000. Other project costs are $4,000 for navigation aids and annual maintenance costs of $10,000 for the breakwater and $100 for additional navigation aids. The design provides the most practical and economic means of meeting the general navigation needs of Monhegan Island. Navigation benefits resulting from construction of the breakwater have been evaluated for reduced damages to lobster boats and equipment, increased lobster catch, increased recreational boating and reduced delays to commercial vessels requiring pilots from Monhegan. The sum of these evaluated annual benefits is $36,150, which when compared to the annual charges for the improvement indicates a benefit cost ratio of only 0.9 to 1.

CONCLUSIONS

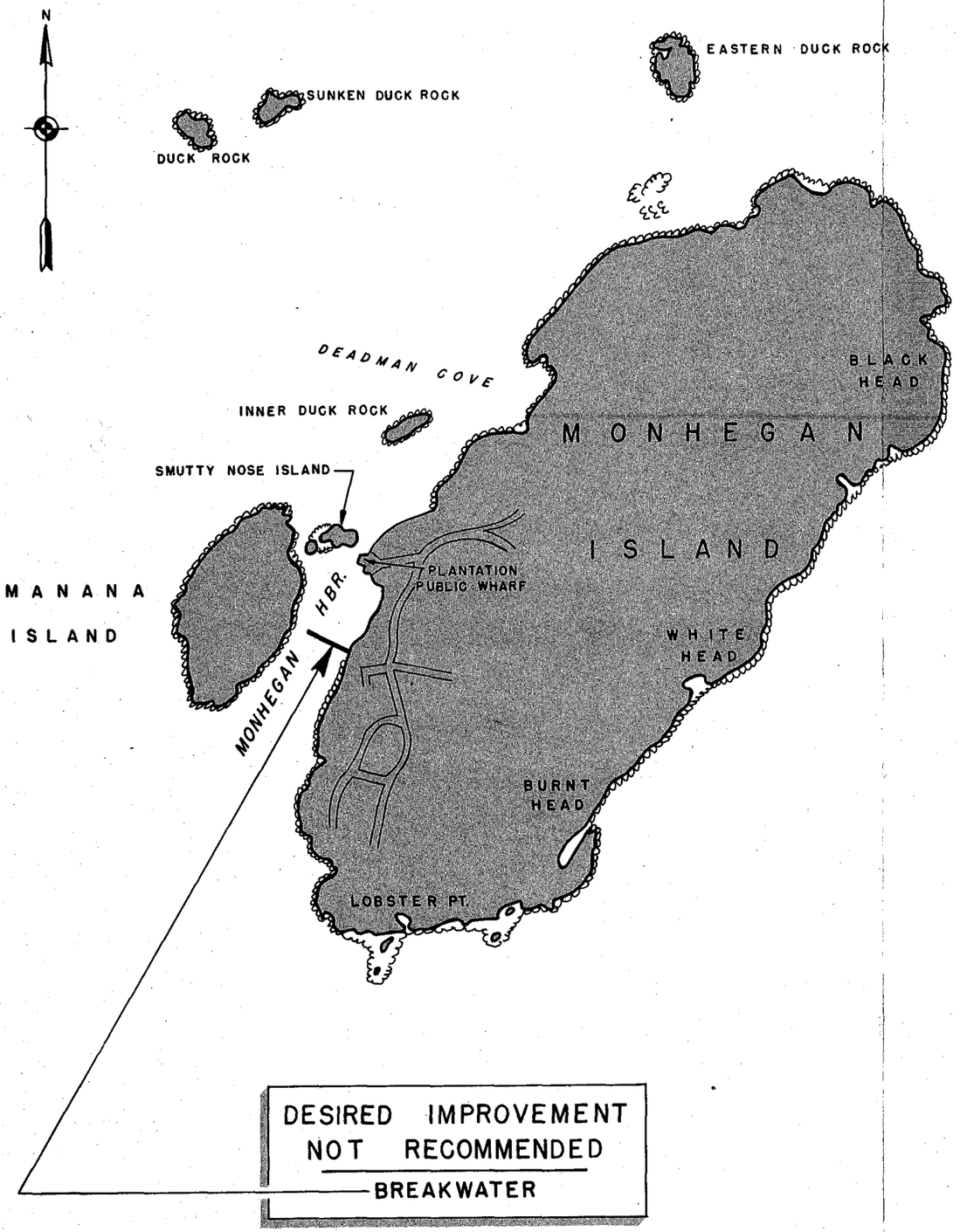
45. Present conditions at Monhegan Harbor result in damage to the local lobster fleet and gear, limit the lobster catch, restrict the use of recreational craft, and result in delays to commercial vessels requiring pilots. All of these problems and the risks involved in using the harbor could be substantially reduced by the construction of the considered breakwater, however the benefit-cost ratio of 0.9 indicates that the improvement is not economically justified.

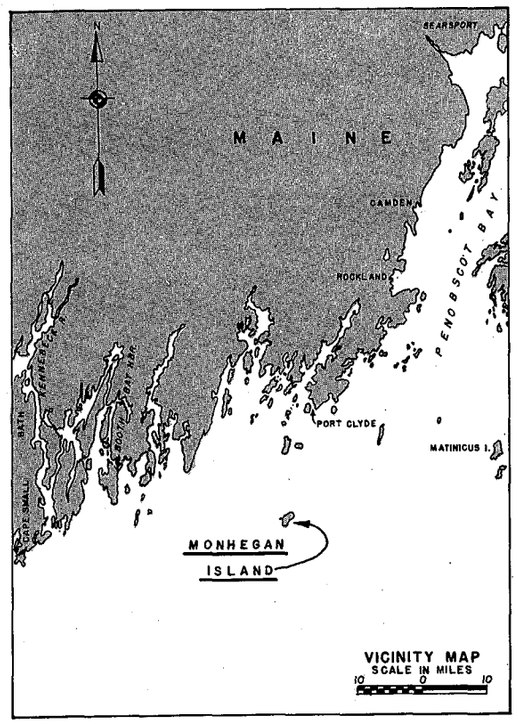
46. Consideration of a smaller structure indicates that less protection would sharply limit the benefits, and that a larger structure would not substantially increase the benefit. Therefore, it is concluded that construction of a breakwater to protect Monhegan Harbor is not warranted at this time.

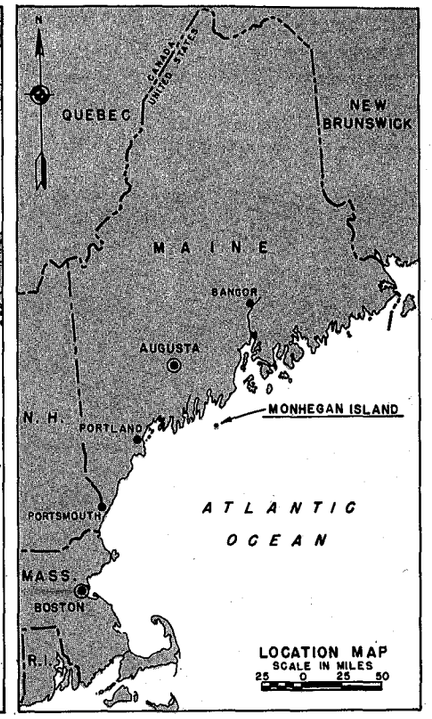
RECOMMENDATIONS

46. In view of the above the Division Engineer recommends that no improvement of Monhegan Harbor, Maine be made at this time.

SEYMOUR A. POTTER, JR.
Brigadier General, USA
Division Engineer







U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

MONHEGAN HARBOR, MAINE

SHEET 1 OF 2 SCALE IN FEET 1000 0 1000 JUNE 1962

APPROVED:
CHIEF, ENGINEERING DIVISION

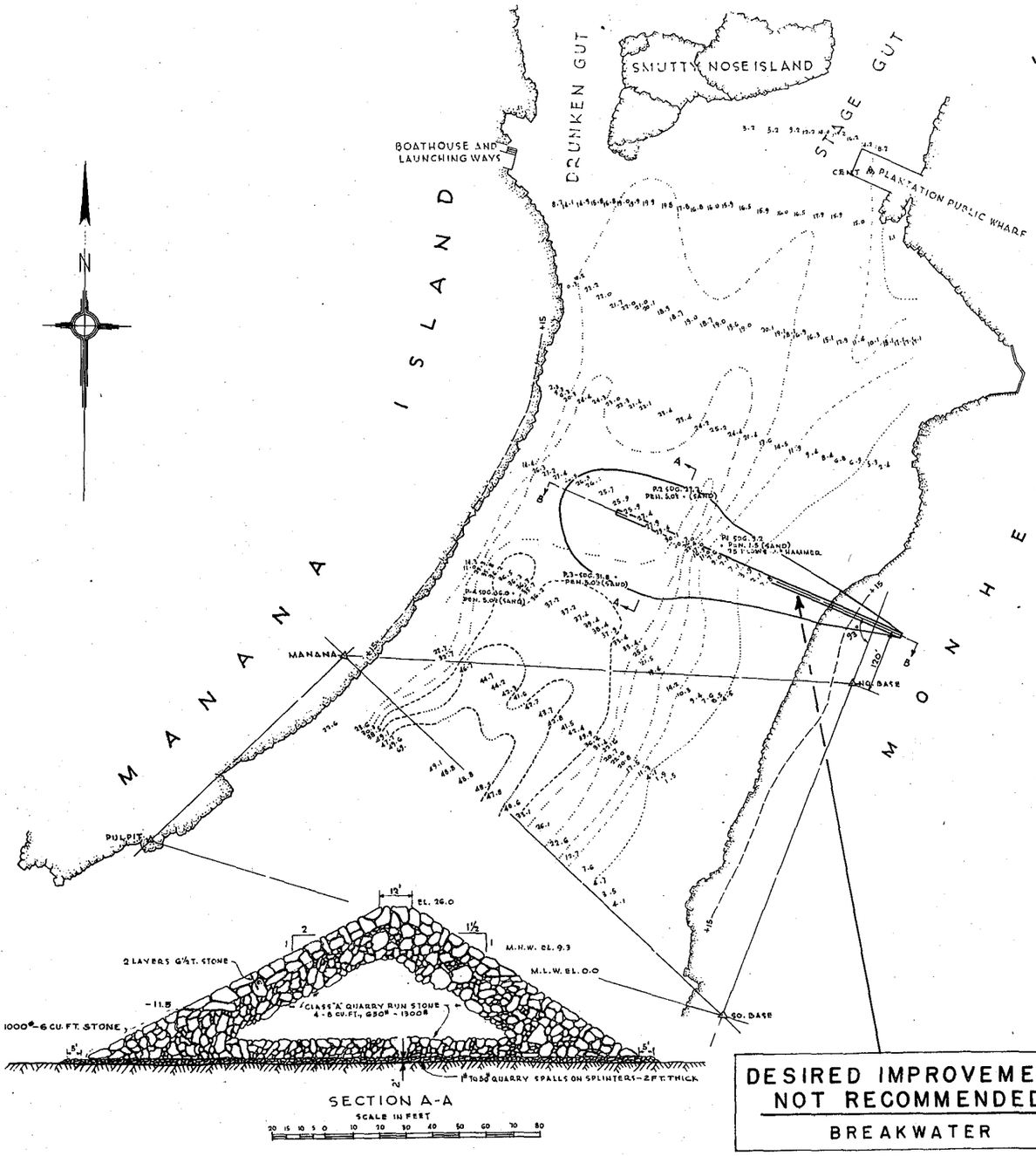
SUBMITTED:
CHIEF, PLANNING BRANCH
CHIEF, RIVER AND HARBOR SECTION
PROJECT ENGINEER

DR. BY S.J.B.
TR. BY S.J.B.
CH. BY

TO ACCOMPANY SURVEY REPORT DATED: JULY 16, 1962

FILE NO. 1525-D-5-4

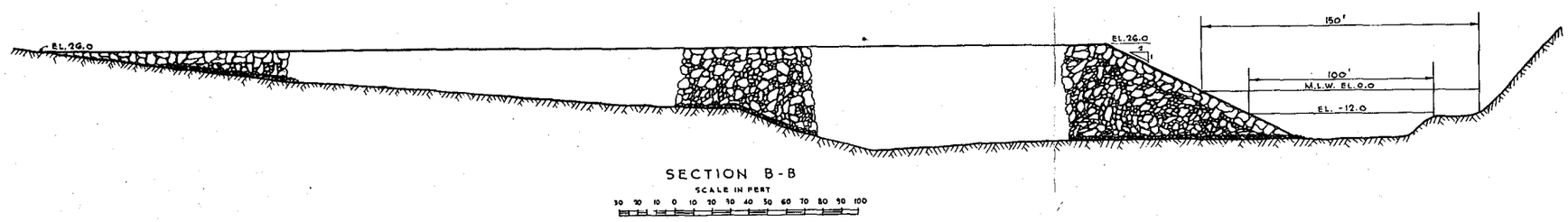
PLATE 1



SECTION A-A
SCALE IN FEET
20 15 10 5 0 10 20 30 40 50 60 70 80

DESIRED IMPROVEMENT NOT RECOMMENDED

BREAKWATER



SECTION B-B
SCALE IN FEET
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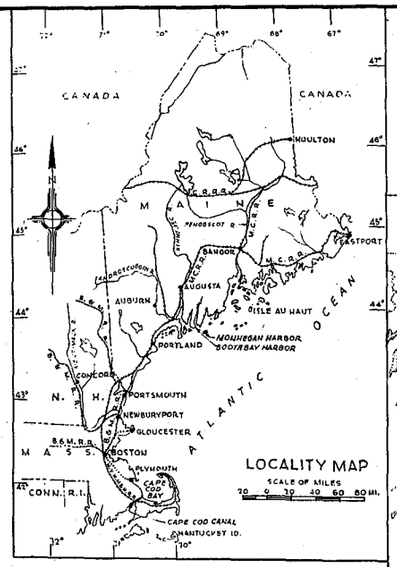
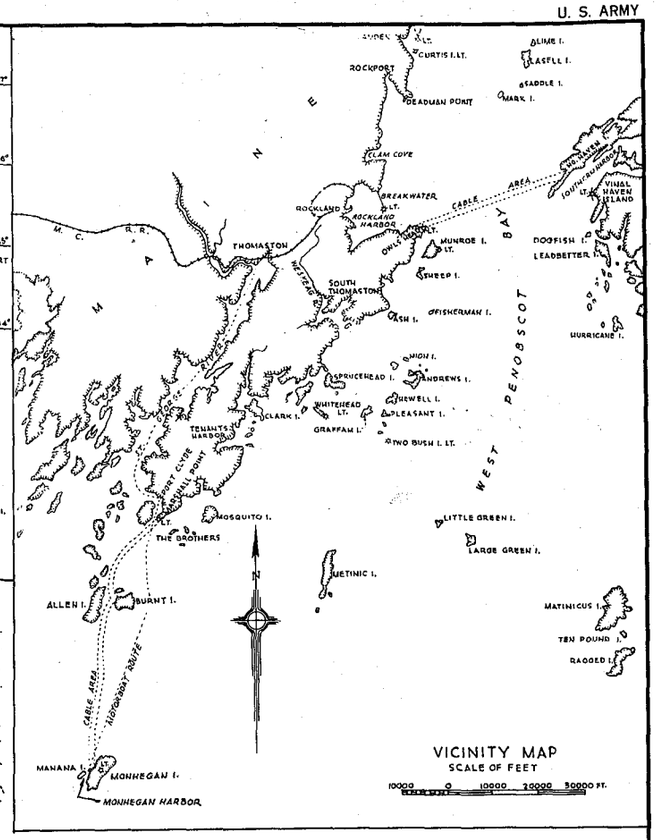


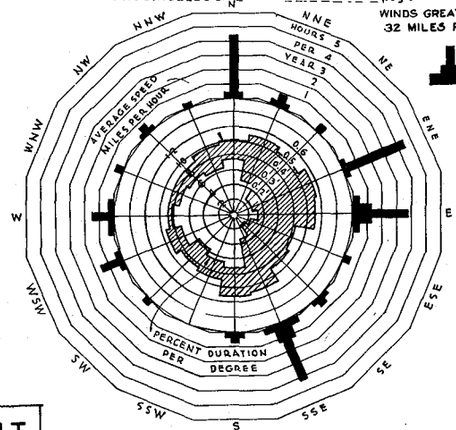
LOCALITY MAP
SCALE OF MILES
20 0 20 40 60 80 MI.



VICINITY MAP
SCALE OF FEET
10000 0 10000 20000 30000 FT.

LEGEND

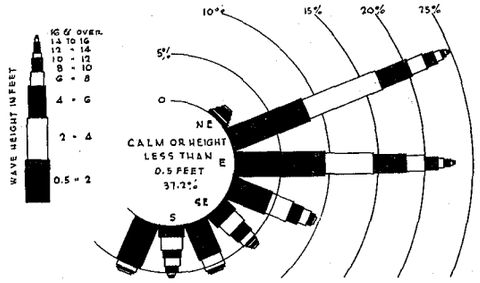
MEAN LOW WATER LINE ---------- LEPOS
MEAN HIGH WATER LINE ---------- HEPOS
6 FOOT CURVE OF DEPTH ----------
12 " " " " ----------
18 " " " " ----------
24 " " " " ----------
30 " " " " ----------
36 " " " " ----------
42 " " " " ----------
48 " " " " ----------
DEPTHS BELOW MEAN LOW WATER ... 4.7
ELEV. ABOVE M.L.W. ... +15
PROBINGS ... P-3 •



WIND DIAGRAM
PORTLAND, MAINE
OCT. '49 - SEPT. '59

WINDS GREATER THAN 32 MILES PER HOUR

32-38 M.P.H.
39-46 M.P.H.
47 M.P.H. AND OVER



WAVE ROSE
OFF PENOBSCOT BAY, MAINE
1948 - 1950

NOTES:

SOUNDINGS AND PROBINGS ARE IN FEET AND TENTHS AND ARE REFERRED TO THE PLANE OF MEAN LOW WATER.

HYDROGRAPHY AND TOPOGRAPHY ARE FROM SURVEY BY THE CORPS OF ENGINEERS IN MAY 1960.

PROBINGS WERE ALSO MADE IN MAY 1960.

BENCH MARK No 1. ▲ CENT - COPPER CENT CEMENTED IN TOP OF CONCRETE WALL AT SOUTHEASTERLY COR. OF SLIP ON PLANTATION PUBLIC WHARF - ELEV. 13.609 FT. ABOVE U.S.L.

BENCH MARK No 2. (1943) STANDARD DISK STAMPED "No 2. 1943" SET IN ROCK OUTCROP AT SOUTHEAST COR. OF LARGE STONE PIER, AND FOUR (4') FEET EAST OF THE MORE EASTERLY OF TWIN (UPRIGHT) TANKS; ELEV. 16.54 FT. ABOVE MEAN LOW WATER.

MEAN RANGE OF TIDE IS 9.3 FT.

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

MONHEGAN HARBOR
MAINE

SHEET 2 OF 2 — SCALE IN FEET 100 0 100 200 300 400 500 — JUNE 1962

APPROVED:
Chief, Engineering Division

SUBMITTED
Chief, Planning and Reports Branch

Chief, River and Harbor Sect.

Project Engineer

DR BY DHP
TR BY DHP
CH BY

TO ACCOMPANY SURVEY REPORT DATED: JULY 16, 1962

FILE NO. 1525-D-5-4

MONHEGAN HARBOR

APPENDIX A

ESTIMATE OF FIRST COST

1. The detailed first cost for the proposed plan of improvement is given below. Federal construction consists of the placement of a stone breakwater approximately 450 feet long from the Monhegan shoreline to an elevation of +26.0 with a top width of 12'-0" and side slopes of 2 on 1 for the exposed side and 1½ on 1 for the protected side. The structure would be placed on a 2-foot screen mat of quarry spoils and splinters. The structure core would be Class A quarry run stone of 650 to 1,300 pounds each. The 6-foot thick armor above MLW on the protected side and down to El. -11.5 on the exposed side would consist of 2 layers of 6½ ton stone. The lower portions of the armor below the elevations noted above would be a 6-foot layer of ½ ton stone.

2. The estimate is based upon the use of stone obtained locally from a quarry operation on Manana Island with all construction operations expected to be carried forward from the shore of Manana Island. Quantities of stone were estimated in terms of place measure and estimates based on prices prevailing in June 1962.

PROJECT COST ESTIMATES
BREAKWATER

Cost Account Number	Item	Cost Estimate (x $1,000)
09	Base Stone (2' Blanket)- 4,500 c.y.@ $ 7.00	$ 31.0
	6½-ton face stone - 13,000 c.y.@ $14.00	182.0
	1,000 lb. stone - 5,400 c.y.@ $10.00	54.0
	Quarry run stone - 42,000 c.y.@ $ 9.00	378.0
		$645.0
	Lighterage each way @ $5,000	10.0
		$655.0
	Contingencies @ 15%	98.0
	Total construction cost-	$753.0
30	Engineering and Design	30.0
31	Supervision and Administration	45.0
	Corps of Engineers Total-	$828.0
	Aids to Navigation (Coast Guard)	4.0
	Total Project Cost (June 1962) *	$832.0

* Excludes Preauthorization Studies of $10,000

SURVEY OF MONHEGAN HARBOR, MAINE

APPENDIX B

DESIGN OF BREAKWATER

1. Monhegan Harbor is exposed to storm waves generated from the southwest quadrant. The centerline of the deepest water in the harbor lies roughly along an azimuth of 34°, NE - SW. Storms approaching from the south and southwest result in heavy seas which surge into the harbor and endanger anchored boats and lobster cars and make landings at the public wharf extremely hazardous.

2. A breakwater located at some point along the straits between Monhegan Island and Manana Island and south of the public wharf would best serve the navigation needs of the harbor.

3. From hindcast wave data contained in Technical Memorandum No. 55 for a Station off Penobscot Bay, the duration of waves of various heights and periods from critical directions only were summarized. This data is tabulated on page B-10. The critical directions included the quarter points from the SE to S to W, as shown on page B-9. The summary indicated that wind-generated storms from the south and south-southwest were the most critical.

4. Refraction studies relative to determining design wave heights for breakwaters located at 3 points in Monhegan Harbor (See page B-6), were made for wind-generated waves approaching from the S and SSW with unlimited fetch. Refraction coefficients for the 3 points were computed for a 10-second wave from the S and SSW and for a 5-second wave from the SSW. The refraction study shown on page B-11 indicates that the major refraction occurs within 1/2 mile of the island.

5. Design waves for the 3 breakwater study sites were computed by reducing the significant wave heights by the refraction coefficients. The design wave computations for points A, B, and C are shown on page B-7 and summarized on page B-5.

6. Based on the above design waves and approaching directions, preliminary studies were made of the following locations for a breakwater to shelter the harbor. These locations are shown on page B-4.

a. Two breakwaters, one extending approximately 230 feet south-southeasterly from the tip of Manana Island, the other extending westerly about 300 feet from a point 200 feet north of South Base. (Plan previously considered in an unpublished survey report dated October 1940 and designated as Plan A - one of the two plans under review in this report.)

b. The improvement suggested by local interests; a breakwater 300 feet long, similar to the eastern portion of Plan A described in (a) above.

c. A breakwater extending generally northwesterly about 300 feet from a point approximately 100 feet north of North Base. (Plan also considered in report of October 1940, as above, and designated as Plan B - under review in this report.)

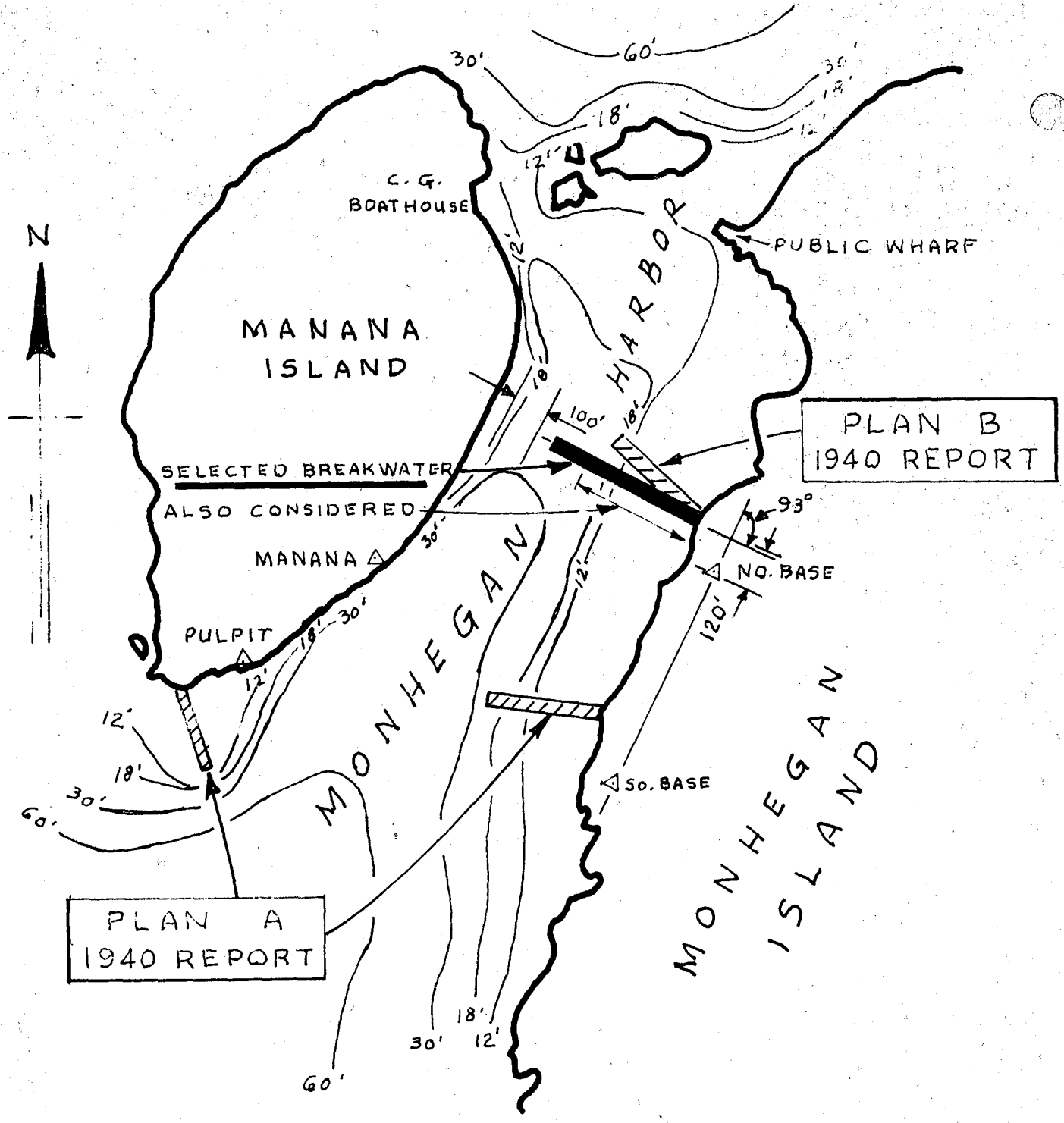
d. A breakwater extending 445 feet from a point 120 feet north of North Base at 93° from a line connecting and extended through North Base and South Base.

e. A breakwater extending approximately 535 feet as (d) above.

7. Preliminary diffraction wave studies were made for those of the above which appeared to warrant further study. Diffraction diagrams for breakwaters listed under (c) thru (e) above and shown on pages B-13 - through page B-16. Page B-12 summarizes the results of the diffraction studies. The preliminary studies indicated that the 535-foot breakwater was the most effective in reducing the storm waves in attaining a greater area of protected anchorage.

8. For the design of the typical section of the breakwater, Hudson's Formula was used. Breakwater design is for a rubble mound structure at Location "C", for a design wave of 11.5 feet, refracted from a 20-foot, 10-second, 512-foot long deepwater wave. Stone available has a specific gravity of 2.65. No active quarry exists at the site: size of stone is therefore open, within that which conventional equipment can manage. Choice of stone size and structure slopes depends on costs. It is considered that 10 ton is a practicable maximum size. Acceptable random stone for the core can be produced by ordinary blasting; all armor stone must be produced by more careful quarrying methods. Cost of armor stone is assumed to rise in some ratio to the size of the blocks. The breakwater is designed for minimum material volumes, with the stone size determined by the Hudson Formula as aforementioned. The computations on stone size are shown on page B-17.

9. Top elevation of the mound, to prevent practically all transmission of wave energy over the breakwater, should be 1.5 H, or 11.5 x 1.5 = 17.25 above high water, or say elevation 26.0 MLW. A lower elevation might be used to block a major part of the wave transmission, but since this harbor is so small, any overtopping would be dangerous. Practice requires that top width provide for two interlocking cap stones. In this case, a 12-foot top width would satisfy this requirement. Core stone would be Class A quarry run stone weighing between 650 and 1,300 pounds varying in size from 4 to 8 cubic feet. To stabilize the sand bottom before starting construction, a layer of 1 to 5 pound spalls should be dumped to form a 2-foot mat extending 5 feet beyond the toes. The 6.5 ton armor course should be in 2 layers, or 6 feet thick, above MLW on the protected side and down to Elev. - 11.5 on the exposed side. Armor stone below these elevations would consist of a 6-foot thickness of 1/2 ton stone. The armor stone should be well keyed and placed with a plane face to establish line and grade. Side slopes would be 2 on 1 for the exposed side and 1.5 on 1 for the protected side. A cross section of the breakwater is shown on the map accompanying this report.



BREAKWATER LOCATION

MONHEGAN HARBOR MAINE

SCALE IN FEET

0 150 300 450 600

FEBRUARY 1961

S.J.B.

DESIGN WAVE FOR BREAKWATERS AT 3 POINTS

The design waves for breakwaters at 3 points in Monhegan Harbor have been determined using 1954 Hindcast wave data from Technical Memorandum No. 55 for a Station off Penobscot Bay, modified by use of refraction diagrams based on U. S. Coast and Geodetic Survey Soundings made in 1944 and Corps of Engineer Surveys of 1931, as follows:

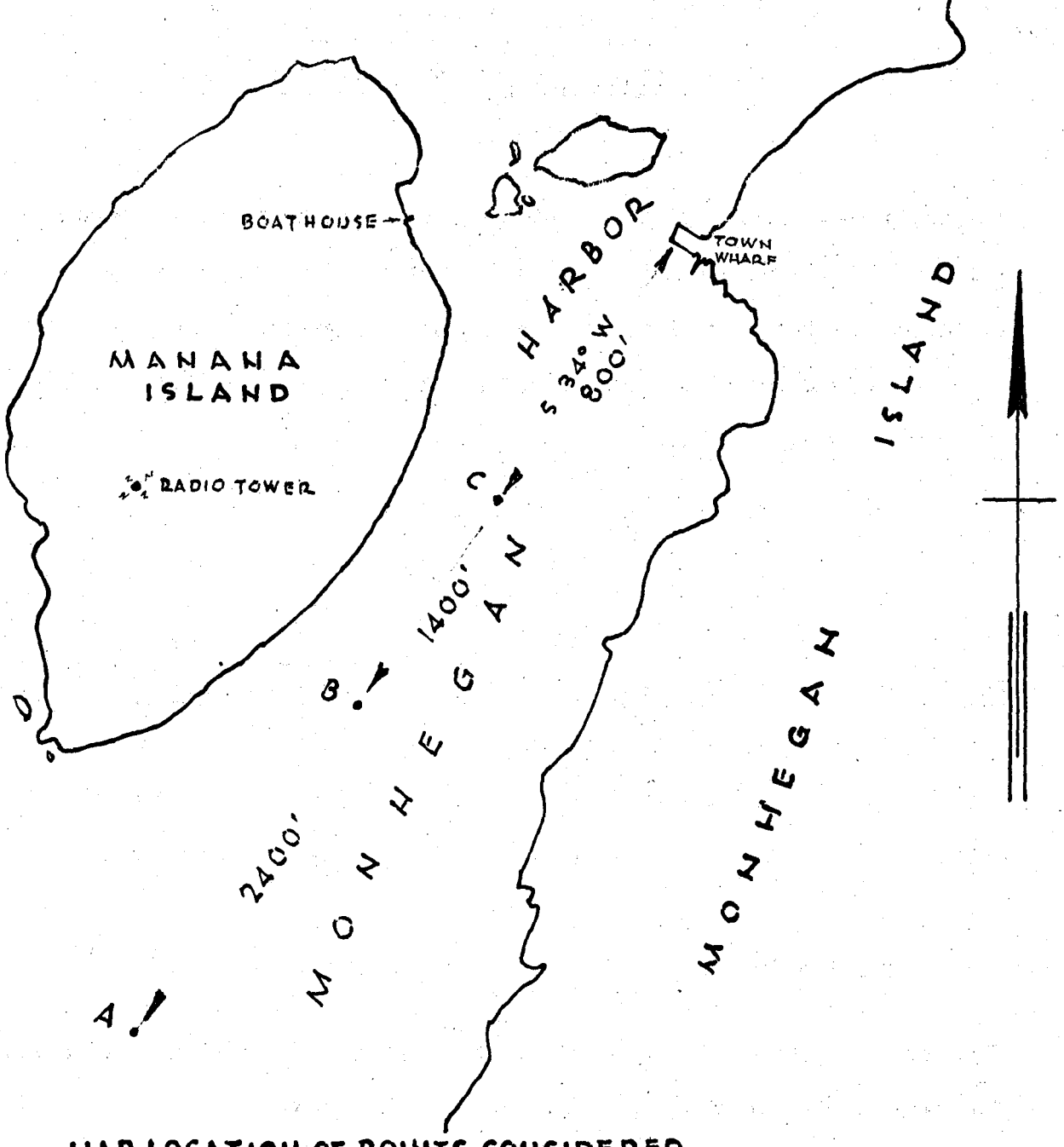
Point	Location	DESIGN-WAVE Height	Period	Direction
A	2,400' S 34° W from Town Wharf	13.5'	10 sec	SSW
B	1,400' S 34° W from Town Wharf	13.0'	10 sec	S34°W
C	800' S 34° W from Town Wharf	11.5'	10 sec	S34°W

This wave height is the significant wave of the expected spectrum.

The azimuth S 34° W is approximately the centerline of the deepest water.

The water depths at the 3 points are: A 100', B 50', C 30'.

Because of the probability of reflection of wave energy from the steep shorelines it is considered that the above values would not be reduced by computations for adjacent points nearer the shore.



MAP LOCATION OF POINTS CONSIDERED

MONHEGAN HARBOR MAINE

SCALE IN FEET

0 150 300 450 600

FEBRUARY 1961

A.R.C.

DETERMINATION OF DESIGN WAVE

	Direction	Significent Wave Height H 1/3	Significent Wave Period T	Kr	H	Use
Point A	S	18	12			Design
			10	.37	6.6	Wave Height
	SSW	20	12			
			10	.66	13.2	13.5'
		8	5	1.0	8.0	
						T = 10 sec
	SW	18	12			
			10	.66	11.9	S 34° W
Point B	S	18	12			
			10	< .35	< 6.3	
	SSW	20	12			
			10	.65	13.0	13.0'
		8	5	.97	7.8	
						T = 10 sec
	SW	18	12			
			10	.65	11.6	S 34° W
Point C	S	18	12			
			10	< .4	< 7.2	
	SSW	20	12			
			10	.57	11.4	11.5'
		8	5	.87	7.0	
						T = 10 sec
	SW	18	12			
			10	.57	10.3	S 34° W

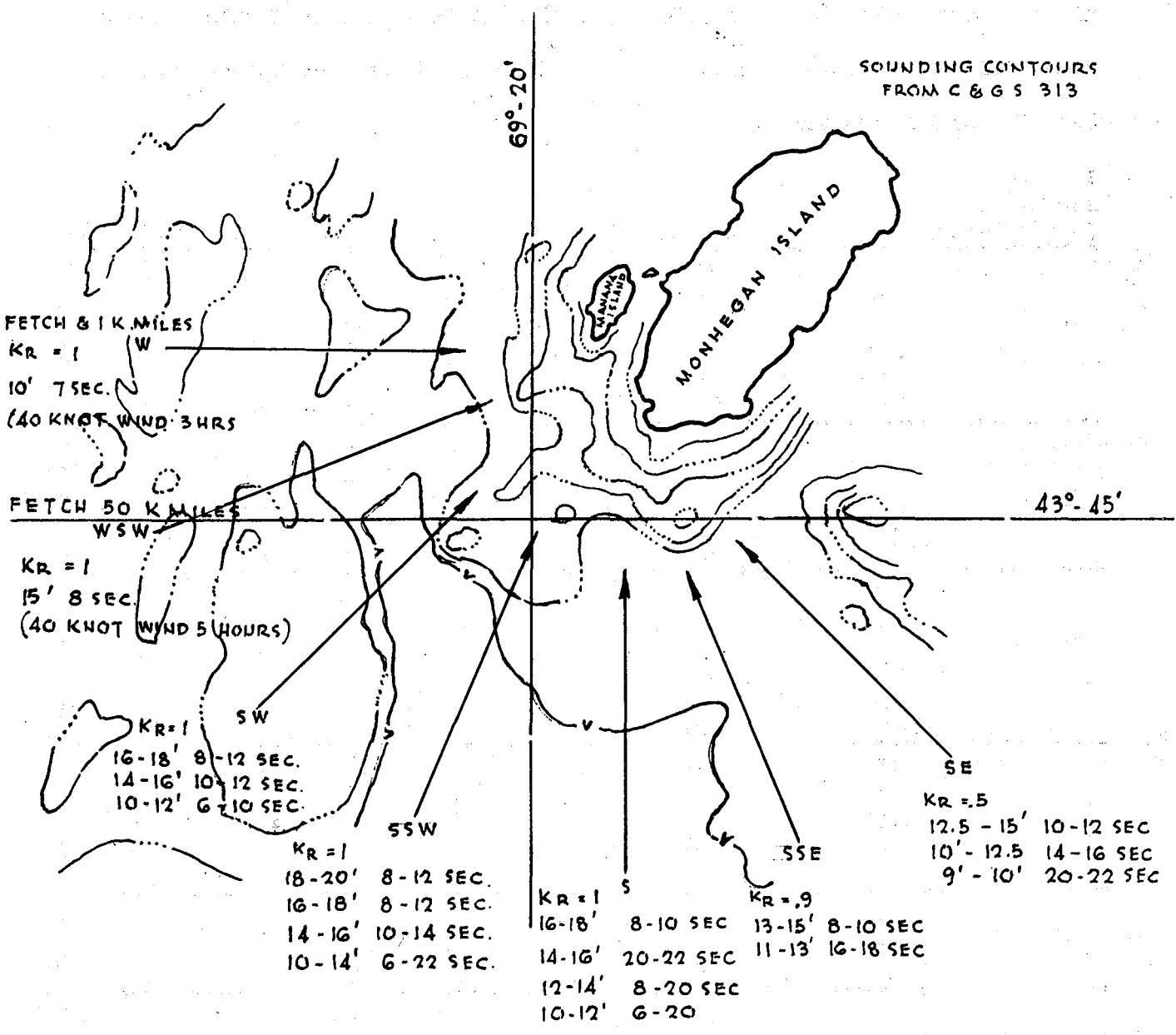
REFRACTION COEFFICIENTS

Refraction diagrams have been drawn for 10 second wave from S and SSW and 5 second wave from SSW.

Refraction Coefficients For	A	A-B	B	A-C	C
10 Second Wave					
From S	.40	1.0	.4	1.	.4
From SSW*	.72	.97	.70	.79	.57
5 Second Wave					
From SSW*	1.00	.995	1.0	.93	.93

* Between A & C S 34° W was used - approximately the axis of deepest water up the harbor.

Shoaling Coefficients For	H_1/H_o'	A	B	C
	L_o \ d	100'	51'	30'
10 Second Wave	512'	.92	.93	.99
5 Second Wave	128'	1.0	.97	.93
Final Kr				
10 Second Wave From SSW		.66	.65	.57
5 Second Wave From SSW		1.0	.97	.87
10 Second Wave From S		.37	.35	.4



ASSUMED K_R & ESTIMATED H & T TO SELECT CRITICAL AREAS FOR FURTHER STUDY

DESIGN WAVE

MONHEGAN HARBOR MAINE

SCALE IN FEET

0 2500 5000

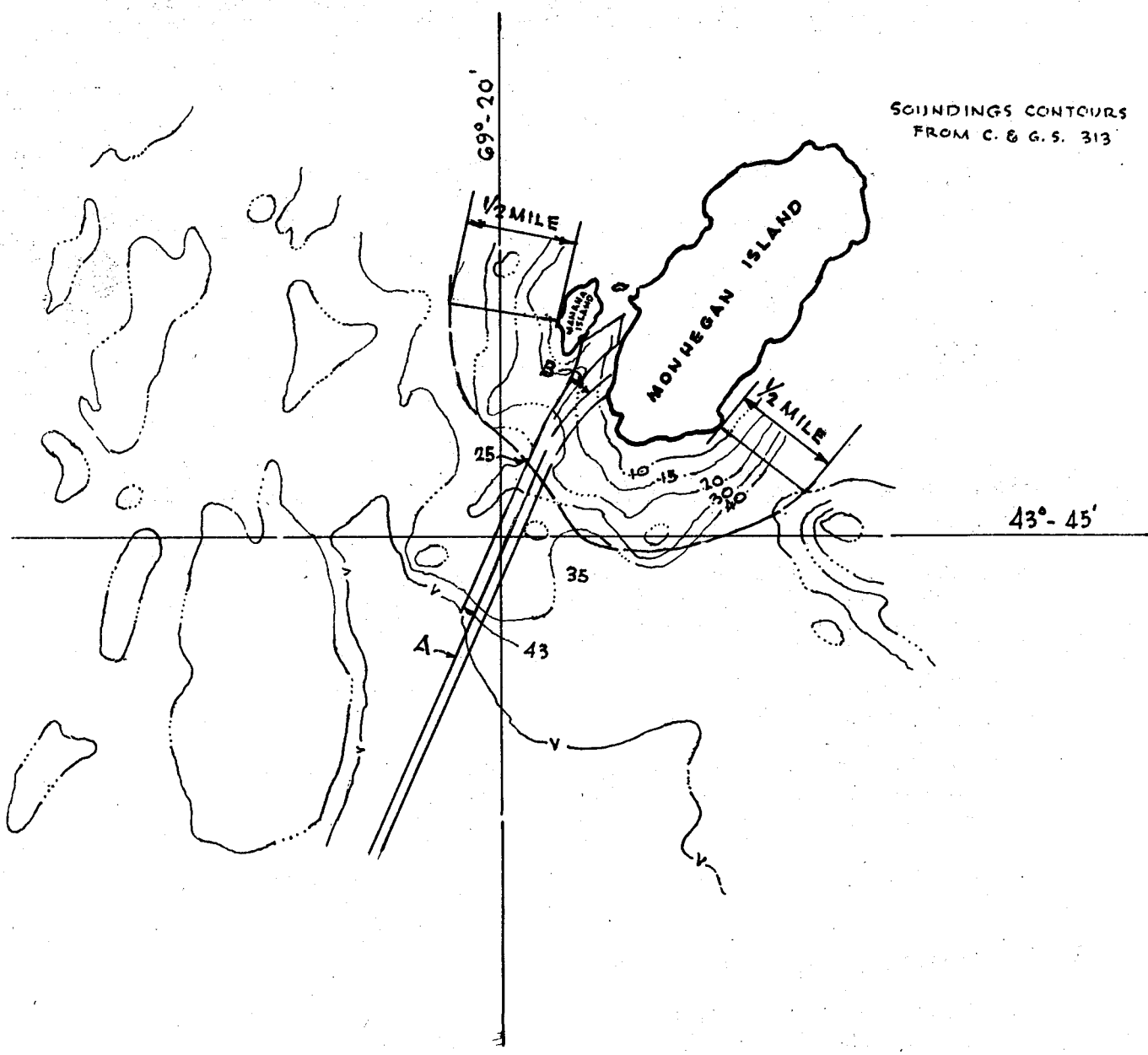
FEBRUARY 1961

A.R.C. 30 NOV. '60

SUMMARY OF HINDCAST DATA

From Table A-1 Technical Memorandum No. 55 Beach Erosion Board November 1954. Hindcast Data - Station A, off Penobscot Bay, Maine - 3 Year Totals - Waves From Critical Directions Only. Duration Given in Hours. Groupings Include Lower Values but Not Upper.

Wave / Height/Period (Feet)/(Sec.)		6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	6-27
	SE	24	20	-	4	4	16	4	-	72
	SSE	4	8	-	8	20	-	-	-	40
10-12	S	16	8	-	4	8	8	12	-	56
	SSW	24	12	-	-	4	-	8	8	56
	SW	8	16	-	-	-	-	-	-	24
	Total	76	64	-	16	36	24	24	8	248
	SE	-	20	4	-	-	8	-	-	32
	SSE	-	12	-	-	-	4	-	-	16
12-14	S	-	8	4	-	4	-	4	-	20
	SSW	-	16	4	-	-	-	4	-	24
	Total	0	56	12	0	4	12	8	-	92
	SE	-	12	8	4	-	4	-	4	32
	SSE	-	12	-	-	-	-	-	-	12
14-16	S	-	4	-	-	-	-	-	8	12
	SSW	-	-	8	4	-	-	-	-	12
	SW	-	-	12	-	-	-	-	-	12
	Total	0	28	28	8	0	4	0	12	80
	SE	-	4	8	-	-	-	-	-	12
	S	-	4	-	-	-	-	-	-	4
16-18	SSW	-	8	8	-	-	-	-	-	16
	SW	-	8	8	-	-	-	-	-	16
	Total	0	24	24	0	0	0	0	0	48
	SE	-	-	-	-	-	-	-	4	4
18-20	SSW	-	4	8	-	-	-	-	-	12
	Total	0	4	8	0	0	0	0	4	16
	SE	-	-	8	-	8	-	-	-	16
20-25	Total	0	0	8	0	8	0	0	0	16
	SE	-	-	4	-	-	-	-	-	4
25-30	Total	0	0	4	0	0	0	0	0	4
	SE	24	56	32	8	12	28	4	8	172
	SSE	4	32	-	8	20	4	-	-	68
10-30	S	16	24	4	4	12	8	16	8	92
	SSW	24	40	28	4	4	-	12	8	120
	SW	8	24	20	-	-	-	-	-	52
	Total	76	176	84	24	48	40	32	24	504



REFRACTION - 10 SEC. WAVE FOR S.S.W.

C_d/C_s FROM TR 4
K_R A → B = 0.7

NOTE:
MAJOR REFRACTION OCCURS
WITHIN 1/2 MILE OF THE ISLAND.

MONHEGAN HARBOR MAINE

SCALE IN FEET
0 2500 5000

FEBRUARY 1961
A.R.C.
6 DEC. '60

SUMMARY - STUDY OF DIFFRACTION DIAGRAMS VARIOUS BREAKWATERS

1. Plan B Breakwater Report Under Review

   a. Would only slightly affect wave heights at Town dock.

   b. Would substantially reduce waves at the beach inside the breakwater.

   c. Would reduce a 10-foot 5-second wave to about 3-feet in about a 1/2 acre area now 6-feet deep.

   d. Would allow occasional higher (4-6 foot) waves in this 1/2 acre area.

2. Breakwater Extending 535' From Point 120' N. of N. Base at 93 Degrees From Line N. Base to S. Base (Leaving 150' Between MLW on Breakwater And MLW on Manana Island).

   a. Would substantially reduce wave heights at Town dock,
   to less than 5 feet for 10-foot 5 second wave
   to less than 5 feet for 15-foot 8 second wave.

   b. Would substantially reduce waves along the shore from the Town Dock to the beach.

   c. Would reduce a 10-foot 5 second wave to about 3-feet in about a 3 acre area now 6-feet deep and a 15-foot 8 second wave to about 4-feet.

   d. Would allow occasional higher (4-6 foot) waves in this area.

3. Breakwater Extending 445-Feet As 2. Above.

   a. Would reduce wave heights at Town Dock
   to less than 7-feet for 10-foot 5 second wave
   to less than 7-feet for 15-foot 8 second wave.

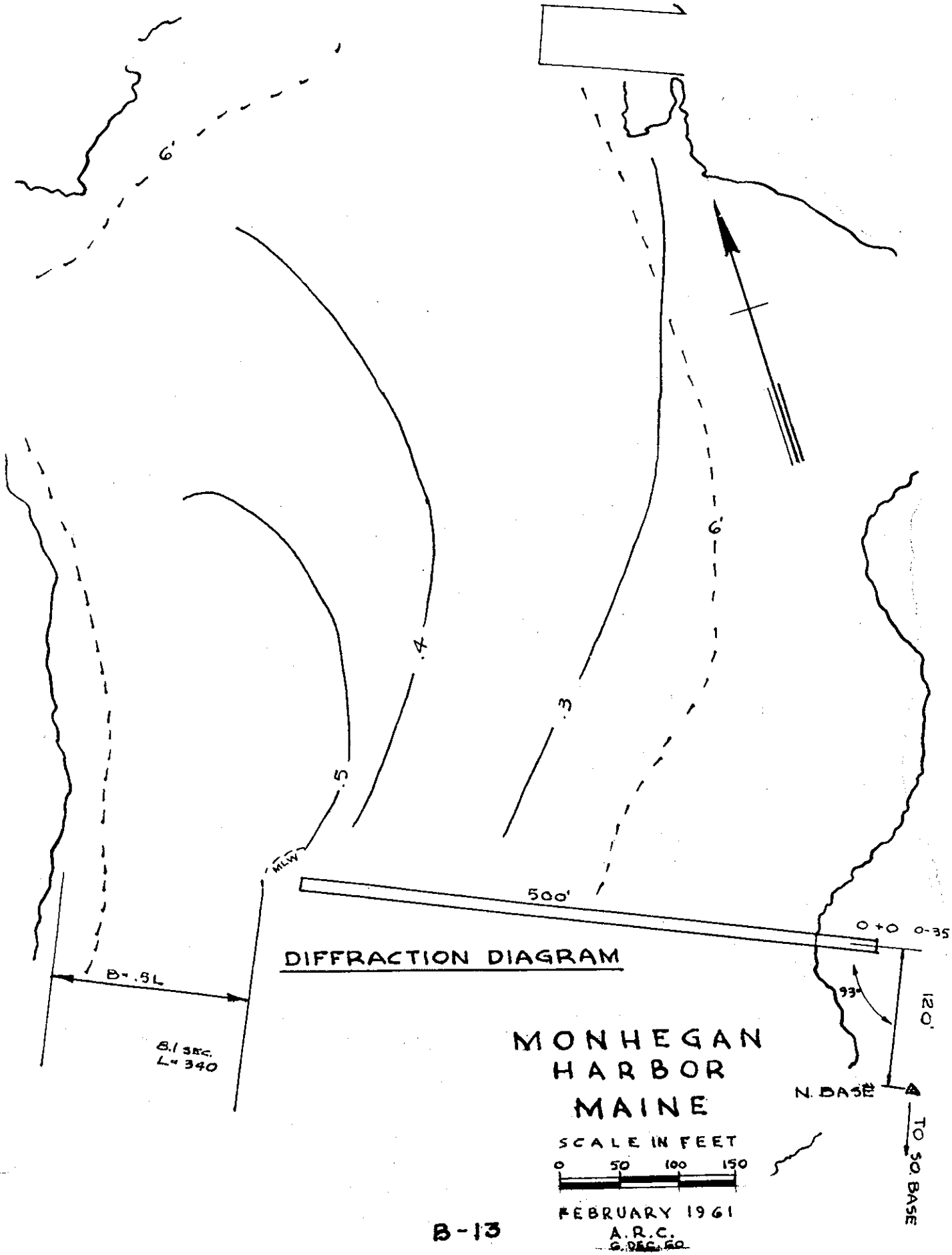
   b. Would reduce waves along shore from Town Dock to the beach.

   c. Would reduce 10-foot 5 second wave to about 3-feet in about a 3 acre area now 6-feet deep and a 15-foot 8 second wave to about 6 feet.

   d. Would allow occasional (6-8 foot) waves in this area.

4. Plan A Breakwaters

   a. Would have no substantial effect on wave heights in the harbor near the Town Dock.



DIFFRACTION DIAGRAM

MONHEGAN HARBOR MAINE

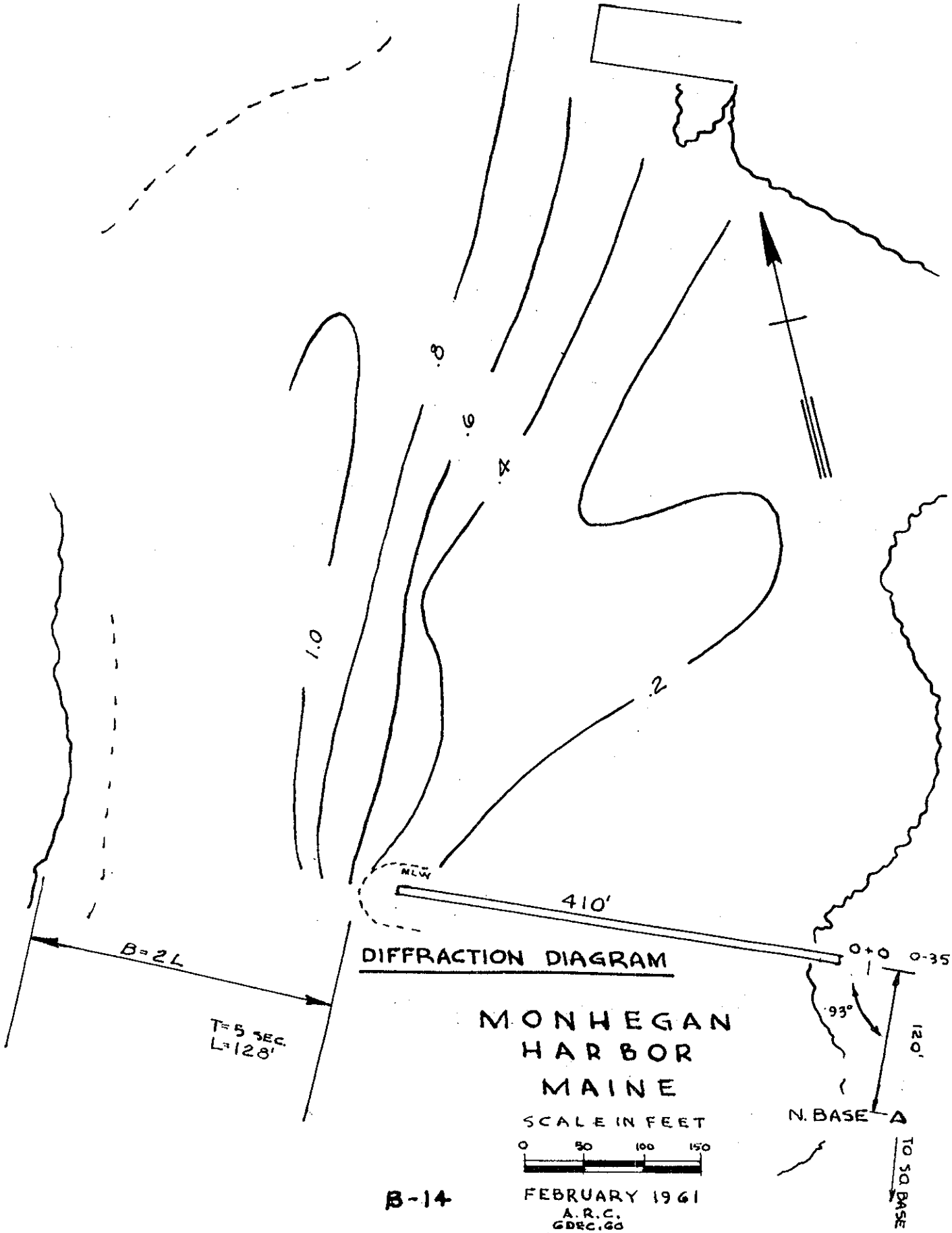
SCALE IN FEET

0 50 100 150

FEBRUARY 1961

A.R.C.

B-13



DIFFRACTION DIAGRAM

MONHEGAN HARBOR MAINE

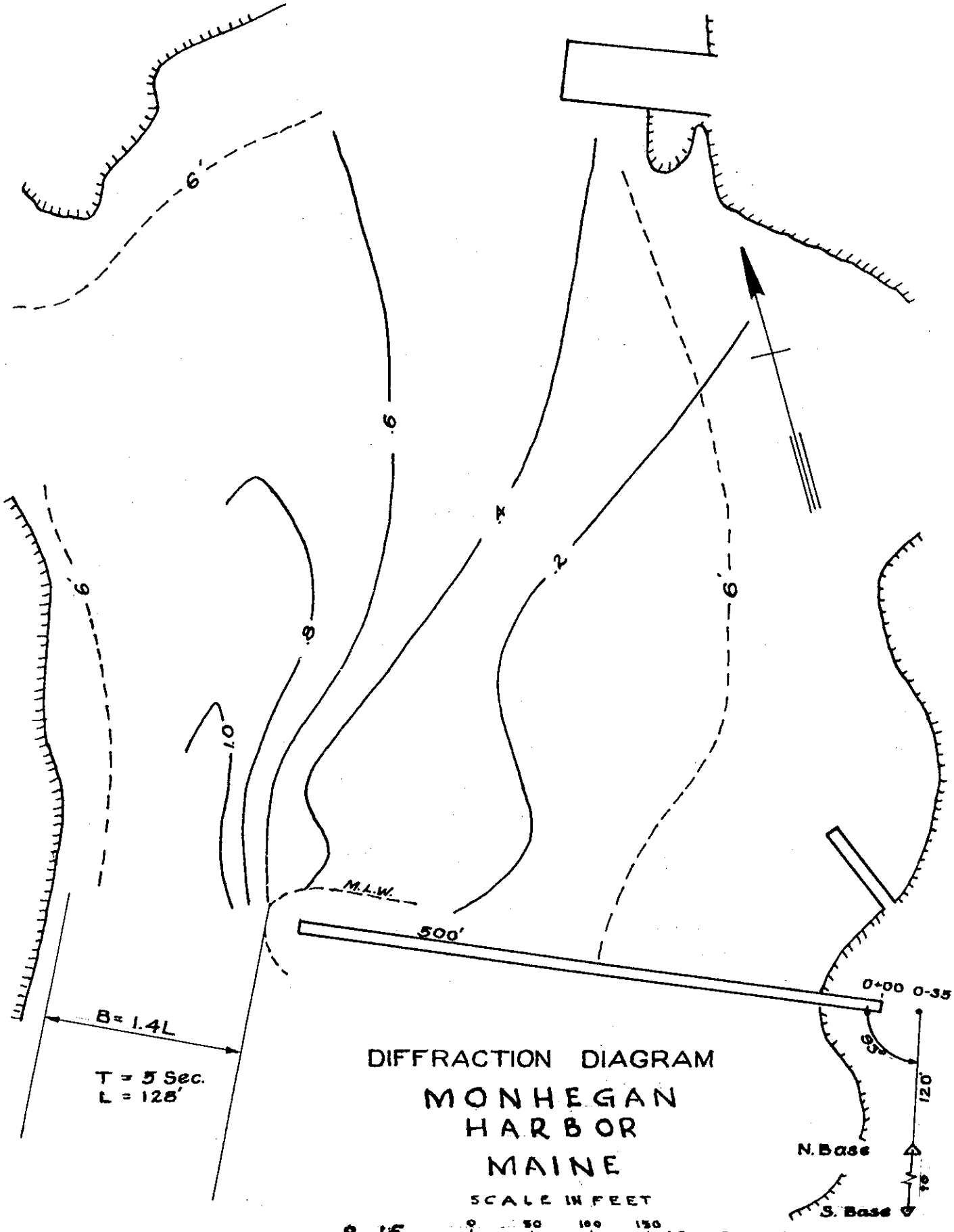
SCALE IN FEET

0 50 100 150

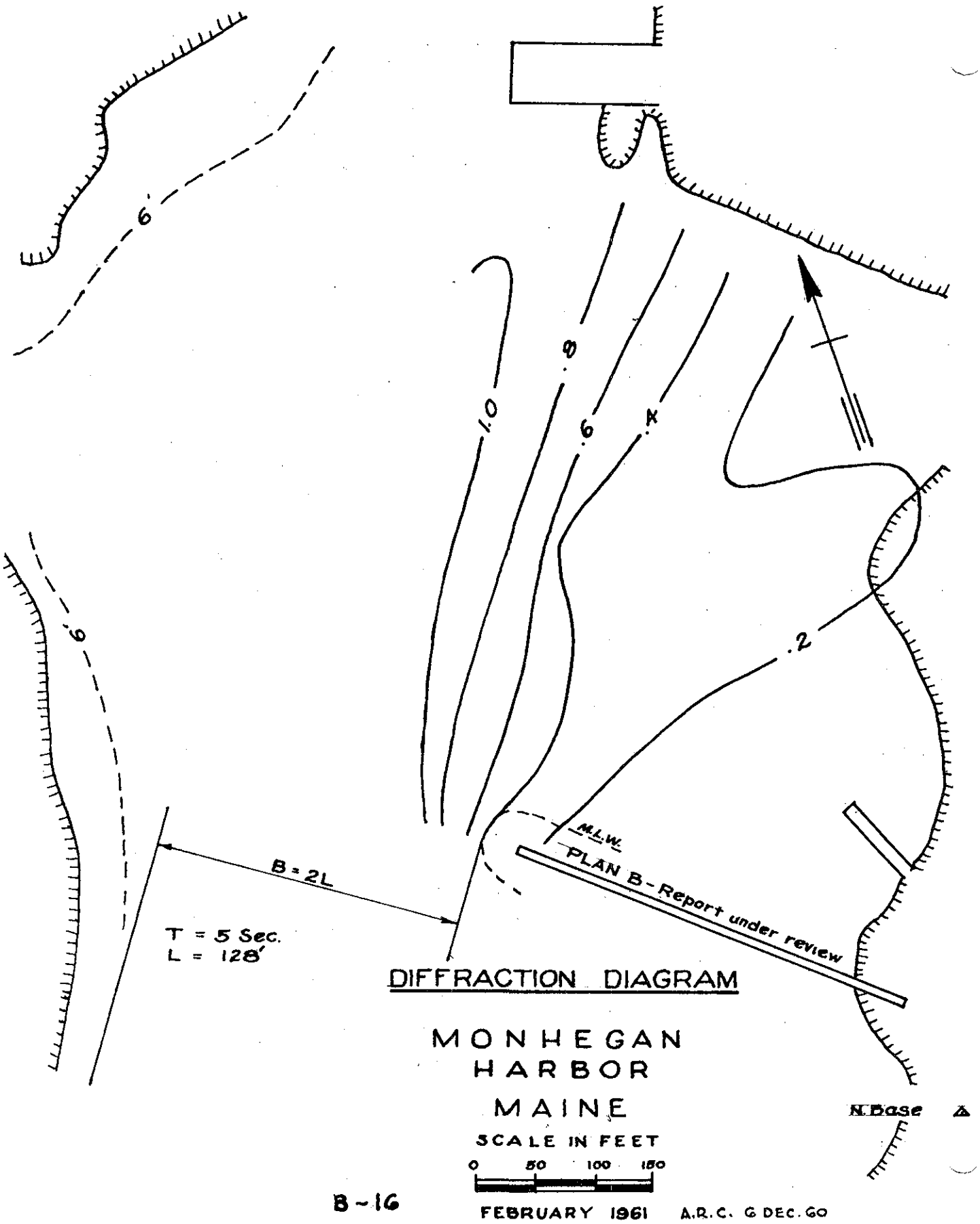
B-14

FEBRUARY 1961

A.R.C.
GDEC.60


6'
6
6'
6'
4
2
0
10
M.L.W.
500'
0+00
0-35
95°
120'
N. Base
S. Base
B = 1.4L
T = 5 Sec.
L = 128'
DIFFRACTION DIAGRAM
MONHEGAN
HARBOR
MAINE
SCALE IN FEET
0 50 100 150
A.R.C. FEBRUARY 1961
6 DEC. '60

B-15



DIFFRACTION DIAGRAM

MONHEGAN HARBOR MAINE

FEBRUARY 1961 A.R.C. G DEC. 60

TRIAL BREAKWATER DESIGN

$$W_R = \frac{W_{SR}\, H^3}{K \quad (S_r - 1)^3 \cot a}$$

$W_{sr} = 165\ \#/ft^3$

$S_r = \frac{2.65}{1.03} = 2.57$

$H = 11.5'$

K (Trunk) 2.5

$$= \frac{165\ (11.5)^3}{2.5(1.57)^3 \cot a}$$

$$\frac{251{,}000}{9.7 \times \cot a} = \frac{25{,}900}{\cot a} = K_x$$

			Tons
SS 1 on 1.5	W_r = 17,200 #	=	8.6
1 on 2.	W_r = 13,000 #	=	6.5
1 on 2.5			
1 on 3	W_r = 8,600	=	4.3
1 on 5	W_r = 5,200	=	2.5

APPENDIX C

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

June 29, 1961

Division Engineer
New England Division
U. S. Army Corps of Engineers
424 Trapelo Road
Waltham 54, Massachusetts

Dear Sir:

In regard to your navigation study of Monhegan Harbor, Maine this constitutes our report. It has been prepared in cooperation with the Maine Department of Sea and Shore Fisheries, and the Maine Department of Inland Fisheries and Game and has their concurrence.

The construction of a breakwater at Monhegan Harbor would have no adverse effects on fish and wildlife resources.

The local lobster fishery is severely hampered by the exposure of the harbor to adverse weather conditions. The lobster resources in the vicinity of Monhegan Island are sufficient to sustain a considerable increase in landings if these conditions could be alleviated.

The additional fishing time made possible by the breakwater would be most effective in January and February when winter storms hold fishermen ashore at a time when daily catches are at their highest and prices are good.

Ten extra fishing days in this winter period when catches may average up to 400 lbs. per day would enable the 15 full-time lobstermen to land an additional 30,000 lbs. of lobsters. Additional fishing days during the rest of the season and additional days when a portion of the fishing area could be worked would bring this annual increase to 35,000 lbs. worth $17,500 at dockside.

This estimate is felt to be conservative in that catches for the additional fishing days have been estimated at a lower catch rate than that which prevails during these periods. This allows for that portion of these catches which would have been made on the days pots would not have been tended.

In addition to this benefit, additional benefits would accrue as a result of reduced storm damages to lobster vessels and lobster cars and to the availability of shelter for mainland fishing vessels which could remain closer to fishing grounds in adverse weather and save the expense of extra running time. These additional benefits have not been evaluated.

The opportunity to report on this project is appreciated.

Sincerely yours,

M. A. Marston
Acting Regional Director
Bureau of Sport Fisheries & Wildlife

Russell T. Norris
Acting Regional Director
Bureau of Commercial Fisheries

MONHEGAN HARBOR

MONHEGAN ISLAND, MAINE

APPENDIX D - ECONOMICS

1. Commerce and Vessel Traffic. - Commerce to and from Monhegan consists of fuel, food and other supplies required by the small community and its summer residents, and lobsters caught by the local fleet and shipped to the mainland. There are 15 lobster boats in the harbor during the January to June lobster fishing season. Some of these same boats ground fish from June to January and all are in the harbor all year except for an average of 60 days when they are dry-docked for maintenance and repair. The total value of all traps, nets, cars and other gear is said to be approximately $200,000. The average value of the annual lobster catch is estimated at $125,000.

2. There are transient fishing fleets of seiners, carriers and trawlers that stop occasionally at the island. There are about 30 of these boats now, but this total should increase to 50 in the future. These boats do not use the harbor for refuge, although they do ride out some storms in the lee of the island if they happen to be in the area. These conditions occur about 15 days per year, according to island residents, and on these occasions it is reported that 6 to 8 fishing boats will stay in the sheltered area. The harbor itself is not large enough for these boats during storms and when really severe storms occur they go to mainland harbors for refuge.

3. A diesel power boat carrying mail and passengers makes two trips daily from Monhegan Island to Port Clyde and Thomaston on the mainland during the summer months, and three trips weekly during the winter. During the summer months an excursion boat makes one trip daily between Boothbay Harbor and the island.

4. There are numerous transient recreational boats that visit the harbor for short daytime stopovers on their way up and down the coast, but leave the harbor before the wind freshens in the evening. There are 8 charter boats which visit the island an average of 20 days each, during the summer season, but do not stay overnight.

5. At present there are 15 lobster boats which moor all year at the harbor except for the 60-day drydock period. In the summer season there are also two sailboats that moor full time, in addition to 75 rowboats and 20 outboards which are normally beached. During the day there may be 4 to 5 transient boats moored for short periods. At this time there is ample mooring space available for additional boats during good weather.

6. No increase in the number of lobster boats based at Monhegan is anticipated to result from breakwater protection. In the future, if the harbor were improved, the home port recreational fleet requiring anchorage is expected to increase from 2 to 11 boats. The present 75 rowboats and 20 outboards are expected to number 110 and 40 respectively in the future; however, these boats will be beached and therefore will not require mooring space.

7. The transient recreational fleet is expected to expand from 260 boats of all classes to 602, all but 35 of which would require mooring space when in the harbor. With the exception of 16 charter cruisers that are estimated to spend an average of 20 days each at the harbor, these boats are expected to moor only 1 or 2 days each during the 10-week cruising season.

8. On this basis, during the 10-week summer seasons the home fleet would require an average of 9 mooring spaces for recreational boats and 8 for the lobster boats not in drydock. The transient recreational fleet would need an average of 17 mooring spaces with a probable maximum of 28. This last figure is based on half the 16 prospective charter boats plus 20 other transient boats.

9. Thus, for the summer months a probable maximum of 45 mooring spaces would be required. This number would provide adequate additional mooring spaces for all boats seeking refuge in the harbor during the winter months when the entire 15 boat lobster fleet would be in the harbor. The following table shows the existing and prospective use of the harbor.

		Fleet Based at Monhegan		Transient Craft	
Category	Size Feet	Present No.	Prospective No.	Present No.	Prospective No.
Commercial					
Lobsterboats	30	15	-	-	-
Trawlers	40-60	-	-	30*	50
Total Commercial		15	-	30	50
Recreational					
Rowboats	10	75	110	-	-
Outboards	10-20	20	40	35	35
Inboards	10-20	-	-	50	50
Cruisers	15-30	-	-	45	135
"	31-50	-	-	25	75
"	51-60	-	-	10	30
Aux. Sailboats	15-30	-	2	12	36
" "	31-40	-	-	10	30
" "	41-60	-	-	5	15
Sailboats	10-20	-	-	5	15
"	21-30	2	7	20	60
"	31-40	-	-	20	60
"	41-60	-	-	15	45

Category	Size	Fleet Based at Monhegan		Transient Craft	
Recreational	Feet	Present No.	Prospective No.	Present No.	Prospective No.
Charter Cruisers	21-35	-	2	-	-
" "	36-50	-	-	5	10
" "	51-100	-	-	3	6
Total Recreational		97	161	260	602

* These boats do not actually use the harbor at present, but are in the vicinity of Monhegan Island at times.

10. Estimates of Benefits. Construction of a breakwater at Monhegan Island would result in considerable annual benefits. The principal use of the harbor is now by the commercial lobster fleet which accepts the present hazard of the open harbor for the monetary gains to be obtained. If the harbor is improved for lobster boats and other commercial fishing craft, use of the harbor as a home port and as a port of refuge would be expanded. There also would be benefits to recreational craft attracted to this picturesque island during the vacation boating season.

11. Additional Lobster Catch. - Benefits to the present fleet of fishing lobster boats are occasioned principally by the elimination of lost time due to storms when the boats cannot leave the harbor to gather the catch or pull the traps out of danger spots. The Monhegan lobster fishermen have an open season of 176 days from 1 January to 25 June. (It has been found over a period of years that limiting the open season has been profitable because the lobsters propagate more rapidly and grow larger during the closed season, resulting in better catches during the open season that bring better prices because of the lobster size). The average daily catch over the season is about 150 lbs.; and during January and February, the daily catch runs as high as 400 lbs. The open season is also the worst season in terms of frequency and severity of storms and the residents of Monhegan indicate that an average of 41 days per boat of fishing time is lost each year because of the open harbor.

12. The U. S. Fish and Wildlife Service reports that the local lobster fishery is hampered by the exposure of the harbor to adverse weather conditions. The lobster resources in the vicinity of Monhegan Island are sufficient to sustain a considerable increase in landings if these conditions could be alleviated. The additional fishing time made possible by the breakwater would be most effective in January and February when winter storms hold fishermen ashore at a time when daily catches are at their highest and prices are good. Ten extra fishing

days in this winter period when catches may average up to 400 lbs. per day would enable the 15 full-time lobstermen to land an additional 30,000 lbs. of lobsters. Additional fishing days during the rest of the season and additional days when a portion of the fishing area could be worked would bring this annual increase to 35,000 lbs. worth $17,500 at dockside. The Fish and Wildlife Service reported that catches for the additional fishing days have been estimated at a lower catch rate than that which prevails during these periods. This allows for that portion of these catches which would have been made on the days pots would not have been tended.

13. The average price of lobster to the fishermen is 0.55 per pound; gasoline and oil for a day's fishing averages $5.00; and bait for a day's fishing costs $8.00. Maintenance and depreciation are not affected by the use or non-use of the boats during the lost periods of fishing during the storms. The increased operation cost for the additional time spent fishing is estimated as $2,300. Deducting this amount from the gross value of additional catch of $17,500 yields a net gain of $15,200.

14. Reduced Gear Damage. - Another benefit to the lobster fleet would be the savings resulting from less damage to the traps during storms. Each lobsterman sets out an average of 250 traps and during the storms the traps are driven out to sea and lost when the lines attaching the buoys are broken or the traps are driven on the the rocky shores and smashed by the rough sea. If the fishermen could get out of the harbor the traps could be moved out of danger when they drifted and 10 percent of the average trap loss (75) per season could be saved. Traps cost $12.50 each. On the basis of the above averages, the savings in trap costs would be .10 x 75 x $12.50 x 15 = $1,400.

15. Mooring Line Damage. - The mooring line and buoy for each craft moored in the harbor has to be replaced every year at an average cost of $100 each. A protected harbor would save 50 percent of this cost since a normal cost in a protected harbor would be $50.00. The benefit represented by this savings would be 15 x $50.00 = $750.00.

16. Lobster Car Damage. - During the fishing season there are twenty lobster cars on moorings in the harbor. Each car has a capacity of 1,200-1,500 pounds. When the cars are full, the value of the contents of a car may range from $600 to $750. During bad storms, with the unprotected harbor, these cars have broken and the entire contents lost. Heavier construction of cars and heavier mooring lines have reduced losses substantially; however the residents claim that losses presently average $2,100 per year in damage to cars and lobster mortality. It is estimated that one-half of this loss could be eliminated if the harbor were protected, resulting in a benefit of $1,150.

17. Vessel Damage. - The fleet of lobster boats using Monhegan Harbor has been subject to damage from the heavy seas when lines are broken, flotsam driving against the boats and the boats slamming against the wharf and going into shore. No accurate record of all the damages has been kept, however, ten boats at an average value of $8,000 have been lost since 1920, and four have been sunk and recovered at an average cost of $2,000 each for raising and repairing. These losses represent an average of $2,200 per year. If the harbor were protected it is estimated that 50 percent of this damage could be eliminated, resulting in a benefit of $1,100 per year.

18. Shore & Wharf Damage. - The Plantation owns and maintains a public wharf which suffers damage every year because of the pounding it takes in the unprotected harbor. The annual cost for repairs is $1,500 and records indicate that in a 5-year cycle it is necessary to do a major repair job at an average cost of $5,000. On an overall annual basis this represents $2,200 per year damages. If the breakwater were provided, 50 percent of this expenditure could be eliminated - resulting in a benefit and savings of $1,100 per year to the Plantation. This benefit is considered a local benefit.

19. Commercial Shipping Delays. - Monhegan Island is a pilot station for the ships using State of Maine ports and there are 4 qualified pilots on the Island. The pilots claim that they receive approximately 200 requests for pilot service per year and that approximately 15 percent of the requests were made when it was not possible to leave the harbor. On these occasions during the past year the average delay was slightly more than 12 hours. The ships delayed were freighters 10,000 Dead Weight Tonnage and oil tankers of 18,000 Dead Weight Tonnage with operating costs of about $120 and $200 per hour respectively. One pilot claimed that only two of the ships requesting pilot service did not stand by when he was delayed, and a second pilot merely stated that he frequently had requests where delays occurred because he couldn't leave the harbor. There is considered to be a saving in vessel time resulting from the availability of pilots on Monhegan, and although the pilots could operate from other harbors, it is expected they will continue to use Monhegan even if it is not improved. Basing the benefit on an estimate that 8 percent of the ships making requests are delayed (16 vessel trips) an average delay of 12 hours, and an average hourly operating cost for the vessels of $160 per hour, the delay cost to commercial shipping would be 16 x $160 x 12 = $30,720. It is considered that 20 percent of these delays could be eliminated by the protected harbor, which would result in a direct benefit of $6,150.

20. Savings to Transient Fishing Fleet. - The local residents of Monhegan Island claim that the port is used by transient-commercial fishing boats to a small extent as a layover point; and during storms, they anchor off shore in the lee of the Island. Under present conditions if the storm indications are too bad, the boats will go to their home port with running times of 4 to 12 hours. If the breakwater were constructed to provide a safe harbor, it is estimated that the number of fishing boats would increase to at least 50 that use the Island as refuge with the possibility that the port may develop as an emergency supply base. Each of the boats using the island for refuge would save running time to their home port thus gaining on an average, 8 hours of additional fishing time, plus the savings in operating costs. Savings in operational costs would consist only in the amount of fuel saved at $1.00 per hour. Assuming that each ship would remain at Monhegan on the occasion of 4 storms over the period of one year, a total of 1,600 hours and $1,600 would be saved. The U. S. Fish and Wildlife Service indicates that the availability of shelter for this fleet would not result in an additional catch of fish.

21. Recreational Benefits. - The existing and prospective recreational fleets would derive benefits from improvement of the harbor. Benefits have been computed on the basis of annual net return to the owners if the boats were "for hire". In general the net return varies with the type and size of boat, and is expressed in terms of its average depreciated value. The ideal net return is considered the maximum return that could be obtained with full unrestricted use of the harbor. For this harbor the ideal net return varied from 13 percent for the charter boats to 6 percent for the large cruisers. Computations of the benefits considered the difference between the net return now received with the net return that can be received after improvement. The value of net return entailed consideration of such factors as the extremely short season, rough harbor conditions even after improvements are made, and the fact that most recreational craft avoid the harbor at present as an overnight stop over. Future value was based on increased use of the harbor made possible by the improvements.

22. Over the years, Monhegan Island has had great appeal as a picturesque and historical spot for owners of recreational boats, but the rough harbor acts as a strong deterrent to mooring, except for an occasional short daylight stop. Residents on the island hesitate to risk anything except small boats in the harbor, except for the commercial fishermen. For the most part, the small boats can be beached and do not have to be exposed to the rough harbor conditions. Without improvement it is considered that the growth of any resident or transient recreational fleet is stagnated. If the improvement were made, it is believed that there would be an immediate growth as the boat owners would take advantage of the harbor that they have wanted for years.

23. Monhegan Island is situated on the navigation route of recreational boats sailing the Maine Coast. Any wind from the south now creates very rough conditions for a boat moored in the harbor and precludes overnight stop overs. Replies to questionnaires indicated that owners of most craft would like to spend one day and night, both on the cruise up the coast and on their return trip, and some of the replies from Long Island Sound Yacht Clubs indicated that Monhegan would be a focal point for the club cruise if the harbor were improved. However, it is considered that the major proportion of transient recreational craft would continue to stop over at mainland ports because of the availability of supply and repair facilities.

24. Estimates of benefits include an allowance of one day for existing transient recreational craft, and an average of 1.5 days for prospective recreational craft. The exception to this would be the charter boats which now visit the harbor an average of two days a week, and are anticipated to do the same in the future. Except for outboards the number of visiting private recreational boats is expected to double if the harbor is improved. A substantial increase in the home fleet is expected, especially in the smaller sizes. Computations of recreational benefits are shown in the Tables following.

Table 1 - BENEFITS TO EXISTING HOME FLEET

Type of Craft	Length (feet)	No. of Boats	Depreciated Value Average	Depreciated Value Total	Ideal %	Percent Return % of Ideal Present	Percent Return % of Ideal Future	Gain %	Percent of Season at Monhegan	Value $
Rowboats	10-20	75	$ 30	$2,250	10	90	90	0	100	$ 0
Outboards	10-20	20 (beached)	287	5,750	10	60	90	3.0	100	172
Sailboats	21-30	2	2,000	4,000	8	60	90	2.4	100	96
		95 beached		$12,000						$ 268
		2 anchored								
									SAY	$ 300

Table 2 - BENEFITS TO PROSPECTIVE HOME FLEET

Type of Craft	Length (feet)	No. of Boats	Depreciated Value Average	Depreciated Value Total	Ideal %	Percent Return % of Ideal Present	Percent Return % of Ideal Future	Gain %	Percent of Season at Monhegan	Value $
Rowboats	10	35 (beached)	$ 50	$1,750 (new)	10	0	90	9.0	100	$ 157
Outboards	10-20	20 (beached)	300	6,000 (new)	10	0	90	9.0	100	540
Aux. Sailboats	15-30	2	3,500	7,000 (Transfers)	6	60	90	1.8	50	63
Sailboats	21-30	5	2,000	10,000 (Transfers)	8	60	90	2.4	80	192
Charter Cruisers	21-35	2	4,000	8,000 (Transfers)	12	60	90	3.6	50	144
		64		$7,750 New						$1,096
		(55 Beached)		$25,000 Transfers						
		(9 Anchored)							SAY	$1,100

TABLE 3 - BENEFITS TO PRESENT RECREATIONAL TRANSIENT CRAFT

Type of Craft	Length (feet)	No. of Boats	Depreciated Value Average	Depreciated Value Total	Ideal %	Percent Return % of Ideal Present	Percent Return % of Ideal Future	Gain %	Portion of Season at Monhegan	Value $
Outboards	10-20	35 (beached)	$ 287	$ 9,188	10	60	90	3.0	1/70	$ 4
Inboards	10-20	50	500	25,000	8	60	90	2.4	"	9
Cruisers	15-30	45	2,500	112,500	6	60	90	1.8	"	29
Cruisers	31-50	25	5,000	125,000	6	60	90	1.8	"	32
Cruiser	51-60	10	20,000	200,000	6	60	90	1.8	"	51
Aux.Sailboats	15-30	12	3,500	42,000	6	60	90	1.8	"	11
Aux.Sailboats	31-40	10	10,000	100,000	6	60	90	1.8	"	26
Aux.Sailboats	41-60	5	25,000	125,000	6	60	90	1.8	"	32
Sailboats	10-20	5	500	2,500	8	60	90	2.4	"	1
Sailboats	21-30	20	2,000	40,000	8	60	90	2.4	"	14
Sailboats	31-40	20	10,000	200,000	8	60	90	2.4	"	69
Sailboats	41-60	15	13,000	195,000	8	60	90	2.4	"	67
Charter Boats										
Cruisers	36-50	5	5,000	25,000	13	60	90	3.9	20/70	280
Cruiser	21-100	3	20,000	60,000	12	60	90	3.6	20/70	617
		260		$1,261,188						$1,238
		35 beached 225 anchored							SAY	$1,300

TABLE 4 - BENEFITS TO PROSPECTIVE TRANSIENT RECREATIONAL CRAFT

Type of Craft	Length (feet)	No. of Boats	Depreciated Value Average	Depreciated Value Total	Ideal %	Percent Return % of Ideal * Present	Percent Return % of Ideal Future	Gain %	Portion of Season at Monhegan	Value $
Cruisers	15-30	90	$ 2,500	$ 225,000	6	0	90	5.4	1.5/70	$ 260
Cruisers	31-50	50	5,000	250,000	6	0	90	5.4	"	289
Cruisers	51-60	20	20,000	400,000	6	0	90	5.4	"	463
Aux.Sailboats	15-30	24	3,500	84,000	6	0	90	5.4	"	97
Aux.Sailboats	31-40	20	10,000	200,000	6	0	90	5.4	"	231
Aux.Sailboats	41-60	10	25,000	250,000	6	0	90	5.4	"	289
Sailboats	10-20	10	500	5,000	8	0	90	7.2	"	8
Sailboats	21-30	40	2,000	80,000	8	0	90	7.2	"	123
Sailboats	31-40	40	10,000	400,000	8	0	90	7.2	"	617
Sailboats	41-60	30	13,000	390,000	8	0	90	7.2	"	602
Charter Boats										
Cruisers	51-100	3	12,500	37,500	12	0	90	10.8	20/70	1,157
Cruisers	36-50	5	5,000	25,000	13	0	90	11.7	20/70	836
		342		$2,346,500						$4,972
									SAY	$5,000

* "0" Because Fleet Will Not Use Harbor Unless Breakwater Is Built

25. Summary of Benefits. - The total tangible benefits which are estimated to accrue from the proposed breakwater for Monhegan Harbor are summarized below.

Type of Benefit	Allocated		
	General	Local	Total
Increased Lobster Catch	$15,200	-	$15,200
Reduced Damage to:			
Lobster Gear	1,400	-	1,400
Mooring Lines	750	-	750
Lobster Cars	1,150	-	1,150
Lobster Boats	1,100	-	1,100
Savings to Transient Fishing Fleet	1,600	-	1,600
Reduced Commercial Shipping Delays	6,150	-	6,150
Increased Recreational Boating			
Existing Home Fleet	150	$ 150	300
Prospective Home Fleet	550	550	1,100
Present Transient Craft	650	650	1,300
Prospective Transient Craft	2,500	2,500	5,000
Reduced Shore and Wharf Damages	-	1,100	1,100
TOTAL DOLLARS	$31,200	$4,950	$36,150
PERCENT	86%	14%	100%

MONHEGAN ISLAND, MAINE

Information Called For By Senate Resolution 148, 85th Congress,

Adopted 28 January 1958

1. Navigation Problems. - Monhegan Island is located 8 miles off the coast of Maine, 17 miles southeast of Boothbay Harbor, 11 miles southwest of Port Clyde and 46 miles east of Portland, Maine. The island, 8,000 feet long and 3,000 feet wide, has 65 residents and accommodations for over 400 summer visitors. Monhegan Harbor is about 2,000 feet long, lies off the southwest corner of the island and is bounded on the west by Manana Island. The width of the harbor increases from 650 feet at the northerly end (which is partly closed by ledges) to about 1,000 feet at the south entrance. The harbor is used primarily by 15 lobster fishing boats.

2. The chief navigation difficulties are due to rough seas resulting from strong winds from the south and southwest that make it impossible to land and prevent the lobster fleet from leaving the harbor. The harbor is dangerous for entrance and mooring by ships seeking refuge in stormy weather, and the safe area is too small for any increased use.

3. Improvements Considered. - Local interests requested a breakwater to provide protection against storms. The location of the most effective breakwater is about 750 feet from the town dock and extending from the Monhegan Island shore approximately 450 feet to the point which will leave a navigation opening of 100 feet wide at 12 feet below MLW. This design would provide adequate protection for present and reasonably propsective harbor use. Estimated first costs, annual costs and annual benefits are based on June 1962 price levels; a 50-year life, a 2-5/8% interest rate on Federal funds and 3-1/2% on non-Federal funds. The estimated costs are as follows:

a. First Cost of Construction

Federal	$716,000
Non-Federal	116,000
Total Estimated First Cost of Construction	$832,000

b. Annual Charges

	Federal	Non-Federal	Total
Interest & Amortization	$25,900	$4,950	$30,850
Maintenance	10,100	-	10,100
Total Estimated Annual Charges	$36,000	$4,950	$40,950

c. Annual Benefits. - The considered breakwater would result in increased lobster catch, reduced damages to private and public property and boats, elimination of weather delays to the fishing fleets, and provide safe anchorage for commercial and recreational craft. The annual benefits total $36,150, of which $4,950 (14 percent) are considered local in nature.

d. The benefit-cost ratio is 0.9, which indicates that the improvement is not economically justified.

e. If a Federal breakwater project were justified local interests should be required to make a cash contribution of 14% of the construction cost of the improvement, a contribution currently estimated at $116,000; maintain an adequate public wharf, and permit use of wharf and harbor to all on equal terms; provide without cost to the United States, all necessary lands, easements, and rights-of-way for the construction and subsequent maintenance of the improvement; hold and save the United States free from damages that may result from the construction of the improvement and subsequent maintenance of the project; provide a quarry site on Manana Island for all the stone necessary to construct the breakwater.

4. Discussion. - Consideration was also given to a smaller structure, but the reduced protection from a smaller structure would sharply limit the benefits. A larger structure would not substantially increase the benefits. The considered breakwater would provide the most satisfactory and feasible means of meeting the desires of local interests and the needs of navigation at Monhegan Harbor. Although analysis on the basis of a 100-year life would increase the benefit-cost ratio to 1.04, the project is not considered jsutified on the basis of the studies and criteria in the report.